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BLAST INJURIES TO THE EAR

The Texas City Disaster

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FREDERICK R GUILFORD, M D

AND

GAYLORD R CHASE, M D

GALVESTON, TEXAS

THE BLAST, explosion and subsequent fire at Texas City was a catastrophic event, which only those present can fully picture. An ordinary industrial area was suddenly transformed into a city of tremendous havoc and destruction. Numerous reports in the press and a few in the medical literature attested to the magnitude of the disaster. It has been estimated, reliably, that between 3,000 and 4,000 people were injured. The most accurate sources report that approximately 600 persons were killed or reported missing as a result of an incident that took place in the course of a very few minutes. About 800 persons received injuries which were of sufficient severity to require hospitalization in Galveston and the surrounding communities. Four hundred of these were admitted to the John Sealy and affiliated hospitals of the University of Texas Medical Branch within twelve hours. Of this group only a very small percentage were admitted because of burns, an indication that the injuries were all due to the effects, primary or secondary, of the blast. These comments are made solely in an attempt to give one a conception of the enormity of the occurrence.

Articles have appeared in the literature dealing with the effects of blast and concussion injuries, particularly injuries among the personnel of the armed forces during World War II. Boeman¹ reported on 300 cases of injuries to the ear due to blast. In this series, 68 patients had a perforation of one or both tympanic membranes, in 25 of the injured ears, or about 27 per cent, suppurative otitis media developed. Ireland² reported 317 cases of traumatic perforation of the tympanic

From the Department of Otorhinolaryngology, University of Texas Medical Branch

Read before the Section on Laryngology, Otology and Rhinology at the Ninety-Seventh Annual Session of the American Medical Association, Chicago, June 25, 1948

1 Boeman, L. C. Acoustic Trauma, *Ann Otol, Rhin & Laryng* **54** 513-517 (Sept) 1945

2 Ireland, P. E. Traumatic Perforations of Tympanic Membrane Due to Blast Injury, *Canad M A J* **54** 256-258 (March) 1946

membrane, in 32 per cent of which suppuration developed in the middle ear. Silcox and Schenck³ also presented a comprehensive survey of 1,922 patients who sustained surgical injuries due to blast. Of this group, 82 had demonstrable injuries to the ear, 58 of these 82 patients had traumatic perforations of the tympanic membrane, in 25, or 47.6 per cent, suppurative otitis media developed. Henry⁴ reported a series of 292 men with injuries to the ear due to blast, of this group, 152 sustained perforations of the tympanic membrane. In 17 per cent of these a purulent infection of the middle ear developed, and in 4 per cent, clinical mastoiditis.

However, in none of these reports was the entire group subjected to the same, single trauma. The trauma in each group was from various types of bombs and other explosives. Our series of patients were

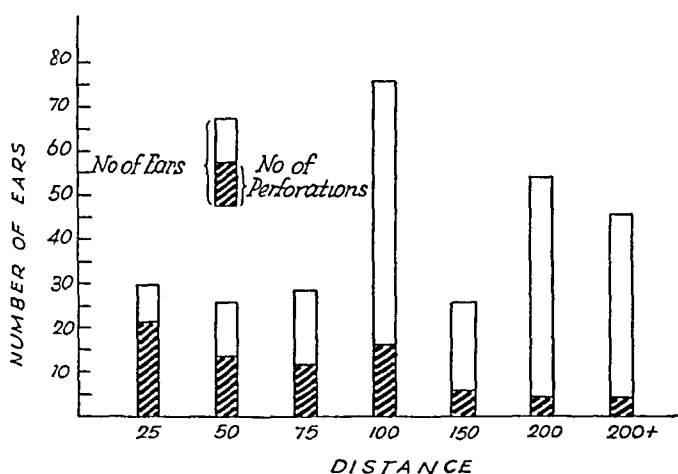


Fig 1—Number of perforations with relation to the distance of the blast

all subjected to the same trauma at the same time, the only variant was the distance from the source, and in some instances there were obstacles between them and the blast.

In our series, 143 patients, or 286 ears, were examined and kept under observation for varying periods. All these patients were hospitalized because of more serious surgical injuries. In this group, there were perforations of 77 tympanic membranes, 25 of which healed spontaneously (fig 1). In contradistinction to other reports, there were few subjective symptoms except for a varying degree of loss of hearing. Of course, a large percentage of the patients with loss of hearing complained of tinnitus, but only occasionally did a patient have any complaints referable to the vestibular apparatus.

3 Silcox, L. E., and Schenck, H. P. Blast Injuries to the Ear, *Arch Otolaryng* **39** 413-420 (May) 1944

4 Henry, G. A. Blast Injuries of Ear, *Laryngoscope* **55** 665-672 (Nov) 1945

One of the most interesting and perplexing features encountered in our patients with perforations of the tympanic membrane was a non-purulent discharge or drainage from the middle ear. The drainage was clear and colorless and, in most instances, persisted for several days. This discharge presented a difficult problem with respect to the prognosis and hospitalization of the patient. It was impossible for us to find a simple test, usable in a large group of patients, by which spinal fluid could be differentiated from a simple, serous transudate.

Several interesting articles in the literature deal with the mechanism of injury to the tympanic membrane from blasts or concussions. Silcox and Schenck³ postulated that six factors are significant in injuries to the ear resulting from blasts: (1) proximity to the source, (2) character of the concussion wave, (3) duration of exposure, (4) awareness of exposure, (5) presence or absence of preexisting aural disease, and (6) use or nonuse of protective devices.

Pearlman⁵ published an interesting article on the reaction of the ear to blast. His idea apparently was that the ossicular chain has a dampening effect, thus diminishing the trauma to the inner ear. He stated that the damage to the ear was due to the concussion wave entering through the external auditory canal and that the rupture of the tympanic membrane during the positive phase of the blast would tend to lessen the damage to the inner ear.

Cantor⁶ presented an interesting hypothesis with regard to the rupture of the tympanic membrane from blasts. He proposed that the injuries were due to the positive phase of the concussion wave entering through the nose and mouth and, in turn, through the eustachian tube, rupturing the membrane outward. This hypothesis also admitted that rupture of the membrane allowed the pressure to be dissipated outward through the external auditory canal, thus minimizing the likelihood of damage to the inner ear.

This hypothesis of Cantor's does not agree with our observations. In our cases the tympanic membrane was blown inward. In many instances the membrane was ruptured and blown against the medial wall of the middle ear, making it difficult, in some cases, to be certain of the presence of a membrane. This would apparently indicate that the rupture of the membrane was due to the positive phase of the concussion wave coming through the external auditory canal. It is difficult to imagine that the negative phase of the blast, acting through the eustachian tube, could produce this picture, particularly after the membrane was ruptured. It was also noted that foreign bodies, such

5 Pearlman, H. B. Reaction of Human Conduction Mechanism to Blast, *Laryngoscope* **55** 427-443 (Aug.) 1945

6 Cantor, J. J. Rupture of Tympanic Membrane Due to Blast. Mechanical Hypothesis, *Ann Otol, Rhin & Laryng* **54** 554-567 (Sept.) 1945

as impacted cerumen, tended to minimize the likelihood of damage to the membrane

The treatment of traumatic ruptures of the tympanic membrane is important. Opinion varies among writers as to the proper method of handling these cases. Ireland² suggested that no local treatment be given, not even cleansing of the external auditory canal, Henry⁴ also advised that no local treatment be used. Silcox and Schenck³ recommended insufflation of microcrystals of sulfathiazole.

Our plan of treatment differed somewhat from other treatments published. In our cases a large amount of foreign material was blown into the external auditory canals. Many of the patients had been blown into the water, and the canals of most persons contained oil, grease and sea water, one patient had a large piece of glass in the canal. In many instances the canals were filled with styrene, a synthetic compound manufactured in the locality.

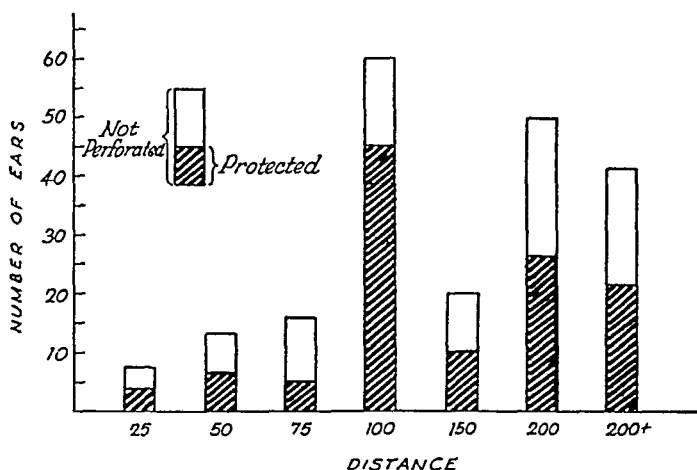


Fig 2—Relation of protection to the number of perforations

All these patients received a uniform type of treatment. They were admitted to the hospital because of the severer surgical injuries, such as lacerations and penetrating wounds. All were potentially infected, so treatment was started immediately with penicillin, 50,000 units being administered intramuscularly every three hours. They had, of course, been given tetanus antitoxin U S P. The local treatment consisted in cleansing the external auditory canal the day after the explosion, in cleansing the canals, sterile instruments were used. Cotton applicators, sterilized after wrapping, sterile ring curets and sterile ear speculums were employed. After the canals were cleaned of foreign debris, the canal and the middle ear, if a perforation was found, were dusted lightly with sterile sulfadiazine powder. This dusting of the canal and the middle ear was continued daily for four to six days. The canal was kept plugged, lightly, with sterile cotton. In no instance was irrigation used to clean the canals, or other medicament instilled.

With this regimen of therapy, in only 1 of these patients did true suppurative otitis media develop, and in none did mastoiditis develop. In some of the other persons not treated by the plan used in our hospital chronic suppurative otitis media developed, for which they were treated subsequently. Our excellent results may be attributed to several factors. First, all these patients were seen and hospitalized within a very short time after the injury. Second, they were all receiving penicillin within a few hours. Third, the external auditory canals were carefully cleansed without forcing foreign material into the middle ear.

In our group, the resulting damage to the cochlea did not differ from injury to the inner ear from other traumatic sources. Audiometric determinations showed varying degrees of deafness, depending on the damage to the tympanic membrane and the proximity to the blast.

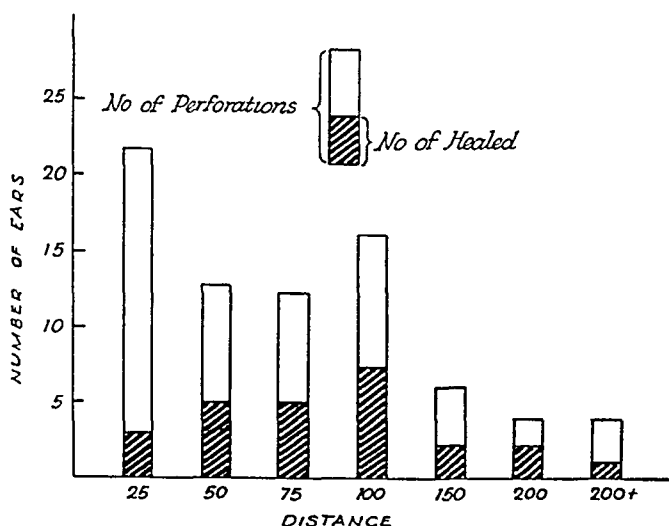


Fig 3—Number of perforations healed

One hundred and forty-three patients, or 286 ears, were examined and kept under observation. Of this group, 77 had traumatic perforations of the tympanic membrane, 63, or 81 per cent, were within 100 yards (92 meters) of the source of the blast (fig 2). Any object which was between the person and the source of the blast offered protection against the positive phase of the blast wave. Of the group that received perforations, only 2 were inside a building. In 91 ears of persons who were either outside or unprotected, no evidence of perforation was present, 75 per cent of these were 100 yards or more from the source.

The remaining 118 were protected by some structure which succeeded in dampening the concussion wave (fig 3). Of the patients kept under observation, only 11 perforations had not healed at the end of thirty days.

ABSTRACT OF DISCUSSION

DR JOHN S KNIGHT, Kansas City, Mo Dr McReynolds and his associates are to be congratulated on their excellent presentation of their findings and their method of handling blast injuries of the ears, as a result of such a catastrophe. Especially are they to be congratulated on their result in treatment.

During my Naval Reserve duty in World War II, I observed many cases of deafness from gunfire and blast. Since then, I have been particularly interested in the prevention of deafness from such causes. Two types of damage to the ear mechanism were observed. Simple rupture of the tympanic membrane might occur and would often heal spontaneously, with no local ill effects or loss of hearing. However, infection would frequently occur before healing, and otitis media, and even mastoiditis, would often develop. Incapacitation of the fighting man was the result, with the coincidental involvement of transportation and medical care.

In the second type of damage to the ear, a number of permanently deafened patients were seen. These patients had intact tympanic membranes and might or might not have other evidences of postconcussion, such as headache, dizziness, nervousness and forgetfulness. In 18 cases, there was loss of function of the vertical semicircular canals, as determined by the Barany caloric test. Audiometric examination in many cases revealed nothing typical. Our timeworn textbook picture of nerve deafness, as manifested by loss for higher tones, was conspicuous by its absence. Frequently, perception was diminished in all tones, and in some cases higher tone perception remained unusually good, whereas the conversational tone range was seriously impaired.

In 1947, the Veterans Administration estimated that "the thunderous din of war damaged the ears of about 40,000 American servicemen."

A sailor, a marine or a soldier in combat must be able to hear a low conversational voice, or even a whispered voice. Protection of the middle and the inner ears by diminution of the intensity of the blast or gunfire is the second important issue. Our effort was directed toward the accomplishment of these two aims in the development of an ear protector. In 1944, I enlisted the aid of then Lieut Comdr James Y Dunbar, U S N R, a physicist and an acoustic engineer. Apparently, the important factor in damage to the ear by blast is the rate of rise of pressure rather than the length of time the pressure lasts. It was decided that the use of a lead impedance was essential.

The V-51 R Ear Warden and other ear protectors, all worth while, had been brought forth. We hoped to develop a hearing guard which would give protection against acoustic trauma, permit almost normal auditory acuity and, in general, answer the requisites for an all-purpose hearing guard, as outlined by Prof Stacy R Guild, of Johns Hopkins School of Medicine and a member of the National Research Council. His requisites for an all-purpose hearing guard are as follows:

- 1 It should assure acoustic protection (a) against loud noises for long periods, with a reduction to 85 decibels or less, and (b) against nearby detonation.
- 2 It should permit hearing of faint sounds or the softly spoken voice, (a) directly, (b) through a telephone or (c) through a headset receiver.
- 3 It should cause no discomfort when worn for hours at a time or when the wearer is chewing.
- 4 It should be so small that no part projects laterally beyond the tragus.
- 5 It should not injure the ear or increase risk, as (a) a secondary projectile if the wearer is struck or (b) from development of fungus or bacterial infection.

6 It should be simple in construction, so that it is (a) easily cleaned and (b) permits of volume production

7 It should provide for rapid and continuous equalization of air pressure, both (a) for comfort and (b) for use of aviators and submarine personnel

The United States Navy has patented the hearing guard, or ear protector, based on the work of my associate, Commodore Dunbar, and myself

Medical Field Research Laboratory, Camp Lejeune, N C, reported, in May 1945, that "Both the *V 51 R* and the *D K* (lead impedance plug) gave similar acoustic protection and were equally acceptable to the men in the field"

In many other experiments involving gunfire and excessive noise on different groups or persons, the wearing of our hearing guard gave protection and comfort, yet permitted hearing Changes in atmospheric pressure incidental to aviation have been well tolerated The nonperforated type of ear protector has been advised against by the School of Aviation Medicine, Army Air Forces

Reduction of damaging warfare noise levels of 130 to 180 decibels and of prolonged excessive noise levels of 100 decibels or more to a tolerable acoustic level of 85 decibels or less has been our object in the development of an all-purpose hearing guard With it, one can hear a whisper at 20 feet, (600 cm) yet still have protection against the "crack" of a 5 inch (127 cm) gun

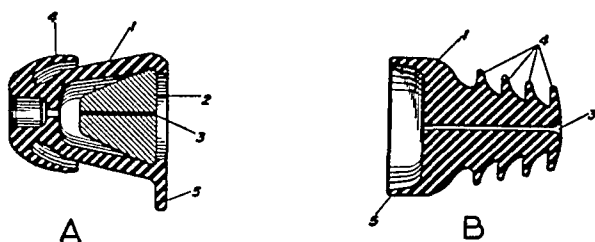


Fig 4—Hearing guard and ear protector (patented by James Y Dunbar and John S Knight, United States Navy, Sept 23, 1947, by United States patent office [2,427,664]) (A) A lead cone, 2, is encased within an outer rubber plug, 1 and 4 A small perforation, 3, 0.030 inch in diameter, or the size of a straight pin, has been made through both the outer rubber shell and the inner lead cone (B) The entire device is made of rubber impregnated with lead, such as the roentgenologists use in their protective aprons and gloves There is sufficient impedance to the rate of rise of air pressure to afford protection A perforation, 3, is noted, and there is a coating of neoprene to prevent contact dermatitis

Many states have recognized occupational acoustic trauma as compensable It is the duty of otologists to recommend measures or means for the prevention of such trauma It is also the duty of the armed services to protect the hearing of those subjected to blast or gunfire

I consider the prevention of deafness far more important than the rehabilitation of the deafened Wherever possible, deafness, partial or complete, from blast, gunfire or excessive noise should be prevented

DR PAUL A CAMPBELL, Chicago The authors must be congratulated on the humanitarian manner in which they handled the cases of injury from such a catastrophe, yet utilized them as a source of material for an ideally controlled scientific investigation The extremely low rate of suppuration is ample testimony that the patients were well cared for The fact that the primary blast wave travels in a dissipating spherical front is well illustrated by the ratio of distance to the number of injuries I should like to ask two questions

1 Was a study made in the cases of unilateral injury concerning the relation of the position of the injured ear to the blast source? In other words, were the injured ears of unprotected persons on the same side as the blast source, or away from it?

2 Did such structures as windows in the area collapse inward or outward?

All must have a profound respect for a group who could make such an excellent scientific investigation during a situation which must have been so hectic

DR. STANTON A. FRIEDBERG, Chicago Dr McReynolds and his group are to be commended on their work Their paper has been of considerable interest to me in that an incident comparable to it occurred overseas during the recent war when a small ordnance group adjacent to an ammunition depot was subjected to an unexpected explosion of the entire stockpile

My colleagues and I felt that there was considerable variation in the aural effects of these blasts, depending on the distance of the victims from the main explosion These men, 30 of them, were sleeping alongside the ammunition dump There was no protection between them and the blast They were admitted to the hospital immediately, most of them with perforations of the tympanic membranes Fifteen were placed under chemotherapy immediately, as a control, 15 others were not The ears were cleaned meticulously, according to the technic described by Dr McReynolds We were unable to demonstrate any difference in the subsequent incidence of aural suppuration among those receiving chemotherapy and those not receiving such treatment

We were impressed by the severity of the nerve deafness which occurred in some of these persons and by the degree of headache, vertigo and other post-concussive symptoms, which were manifest later In addition, the sizable perforations which eventually healed were surprising The great majority of them healed, and the duration of discharge was from three to four weeks

DR. GEORGE S. McREYNOLDS, Galveston, Texas With regard to Dr Knight's protective ear device, such a device is important, because, as we found out after this catastrophe, all the patients who had anything wrong with their ears were cases for compensation, and that sort of litigation will probably be going on for many years before it is all settled If the patients had had any type of protective device, or even if those with known trauma had been made to wear a protective ear device, it would have been a great help In answer to Dr Campbell's question as to which ear was toward the blast in cases of unilateral ruptures It was our impression that when the person had one ear ruptured, it was the one toward the blast Our statistics on that point could not be very accurate, since they depended entirely on the subject's answer, and, of course, many of them had been knocked down and were often unconscious and could not remember clearly which way they were looking when the blast came

As to the way in which the windows were broken, they were, apparently, all blown inward, because the bedrooms of the houses many blocks around the source of the blast were infiltrated with splinters of glass wherever the windows had been shattered and blown into the rooms, the glass penetrating the wood

Dr Friedberg mentioned the size of the perforations in these ruptured ear drums In most instances they were not so much perforations as tears of the ear drum For that reason, perhaps, many of them healed more easily than if they had been simple round perforations

ANATOMY OF THE BRONCHIAL TREE

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AND

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THE HOMOLOGUES found in the study of comparative anatomy fortify opinion as to the significance of any bronchopulmonary segment in the common pattern in the mammalian lung and discount dogmatism as to the final emergence of any particular type in the human lungs

The illustration of Willis¹ (1622-1675) depicts a diagram of a lobe of the lung, showing its subdivisions (fig 1) It closely resembles the illustration by Huntington² (fig 2) It is obvious from a study of comparative anatomy that some of the branches of the embryonic lobar stem bronchus disappear or fuse with others or become aggrandized to take over the areas whose segments have disappeared in the formation of the pattern of the lung of an individual of the species

The question of the entity and nomenclature of the segments of the upper lobe, a problem chiefly concerned with the separate entities of the axillary and anterior segments, has arisen in recent literature In the herbivora a simple form of the upper lobe is seen, as in the black buck (fig 3A), in which there are two main branches One, the lower, is the homologue of the subapical bronchus in the human being, the other, or upper, branch has the homologues of the apical bronchi, the remainder of the branch continuing as the anterior In the dog (fig 3B), the subapical bronchus maintains its separate entity, as it does in all the mammalia The upper branch has the homologues of the apical bronchi (2) and the axillary bronchus, the remainder of the branch continuing as the anterior bronchus Illustrations are shown of simple and of more complicated types of the upper lobe stem, as seen in the pruned casts of those of a monkey (fig 3C) and of man (fig 4) Thus, the pattern of the structure which emerges in the human lung may be traced through simpler forms, seen in some of the lower mammals With this conception it would be just as

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1 Miller, W S The Lung, Springfield, Ill, Charles C Thomas, Publisher, 1936, p 153

2 Huntington, G S in Neal, H V, and Rand, H W Comparative Anatomy, Philadelphia, P Blakiston's Son & Co, 1936, p 345

logical to term the bronchus of the apical segment of the upper lobe a branch of the anterior bronchus as similarly to describe the axillary bronchus

In the mammalia the general tendency is for the apical bronchus of the upper lobe with its two branches to take, as its name implies, a cephalad, or upper, direction. After giving off the axillary bronchus, the remainder of the upper trunk, as in the primates, bends anteriorly or ventrally and continues on as the anterior branch

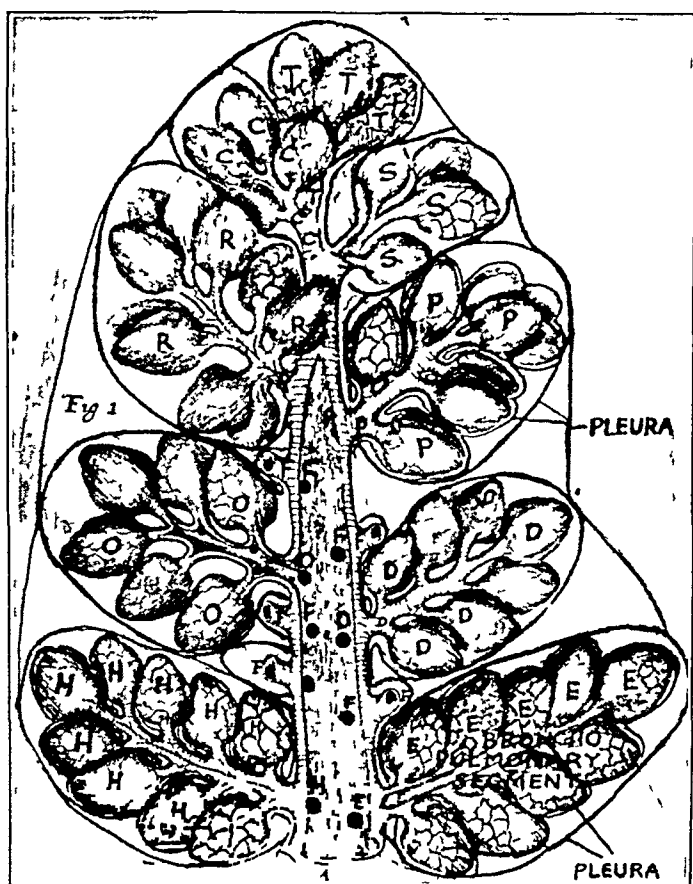


Fig 1—A main stem, bronchus of a lobe of a lung (from Willis', 1676, modified by the authors by lines drawn around potential bronchopulmonary segments, showing their relations to the pleura). *E*, signifies a branch with the secondary lobules, and *F*, an orifice that may supply a segment or a subsegment (accessory to a bronchopulmonary segment) or disappear in conformity with the pattern of the lobe. Other letters are used to designate individual segments,

We have shown³ that in the platypus, dog (fig 3B) and calf there are two separate openings for two apical segments in the upper

3 Neil, J H, Gilmour, W, and Main, W W. Proceedings of the Second Congress of the Pan-Pacific Surgical Association, August, 1936. Neil, J H, Gilmour, W, and Gwynne, F J. *M J Australia* 2 165, 1937. Neil, J H, and others. *Ann Otol, Rhin & Laryng* 46 338, 1937. *Australian & New Zealand J Surg* 8 118, 1938. Hardie-Neil, J, and Gilmour, W. *New Zealand M J* 45 20, 1946.

lobe of the right lung, and that in the platypus there are in the left lung separate openings for the upper and the middle lobe. In man the upper apical segmental bronchus on the right has a very short trunk before dividing to supply two subsegments, an anterior and a posterior, which are well delineated on inflation.

An average, or general, standard pattern of the mammalian lung is found in the sea lion (fig 5). The illustration of the human bronchial tree by Aeby⁴ (fig 6) is in keeping with it.

In the lower lobe the segmental bronchi are given off in succession from above as follows: the apical, the cardiac (on the right side), the

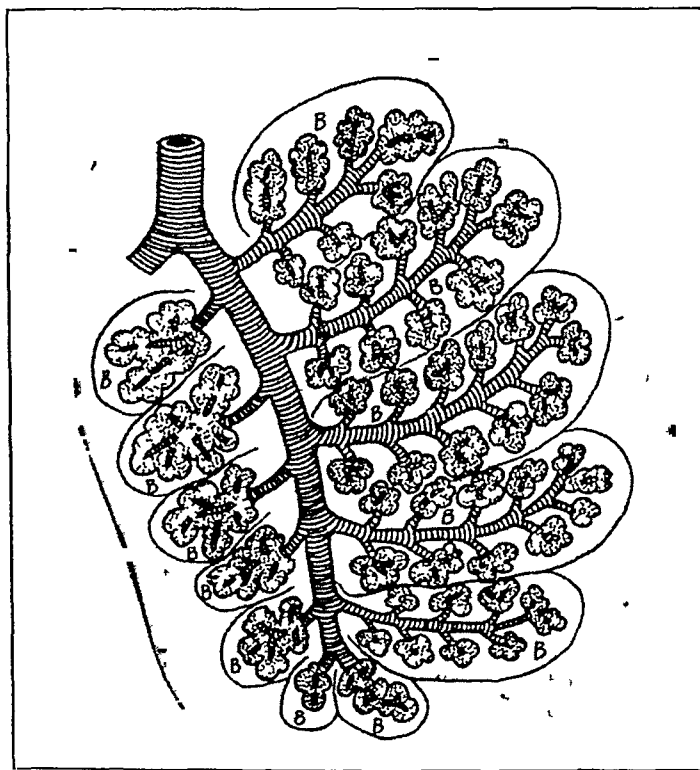


Fig 2—Embryonic stage in the development of the mammalian lung (after Huntington,² redrawn by Neal and Rand and modified by lines drawn around the potential bronchopulmonary segments by the authors)

anterior basal, the axillary basal and the posterior basal. In various positions, from below the apical branch to above the final major division, where the axillary basal branch is given off and the lobar stem bronchus continues onward as the posterior basal bronchus, there may be found from one to three segmental orifices distributed to the subapical segment.

4 Aeby, C. T. *Der Bronchialbaum der Säugethiere und des Menschen, nebst Bemerkungen über den Bronchialbaum der Vögel und Reptilien*, Leipzig, W. Engelmann, 1880.

Recent writers have persisted in showing the subapical area of the lower lobe as part of the posterior basal segment—this in spite of the classic work of the first masters of bronchial anatomy, Aeby and Ewart, the findings in human anatomy and the observation of the constant presence of this area as a separate segment in all mammalia we have

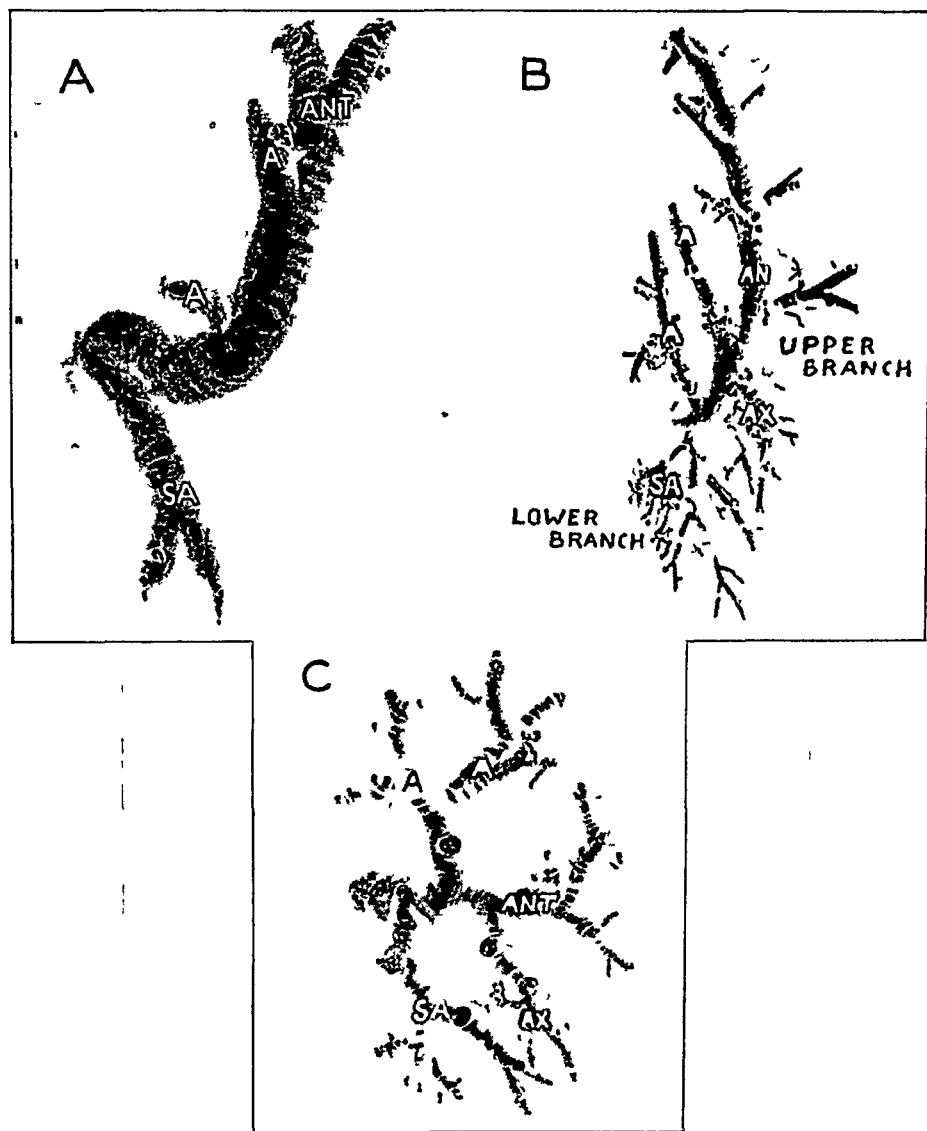


Fig 3—*A*, cast of right upper lobe bronchus of the black buck, showing the subapical, apical and anterior branches, *B*, cast of right upper lobe bronchus of the dog (lateral view), *C*, pruned cast of upper lobe bronchus of the monkey (lateral view) *SA* signifies subapical branch, *A*, apical branch, *AX*, axillary branch, and *AN* and *ANT*, anterior branch

dissected Its omission as a separate segment of the bronchial tree and its inclusion with the posterior basal segment can lead only to confusion, and not to simplification A practical bronchoscopist can

quickly recognize all the segmental bronchial orifices. Similarly, a student who has seen the segmental orifices in an opened bronchial tree of a lung prepared by the Moolten method will have no difficulty

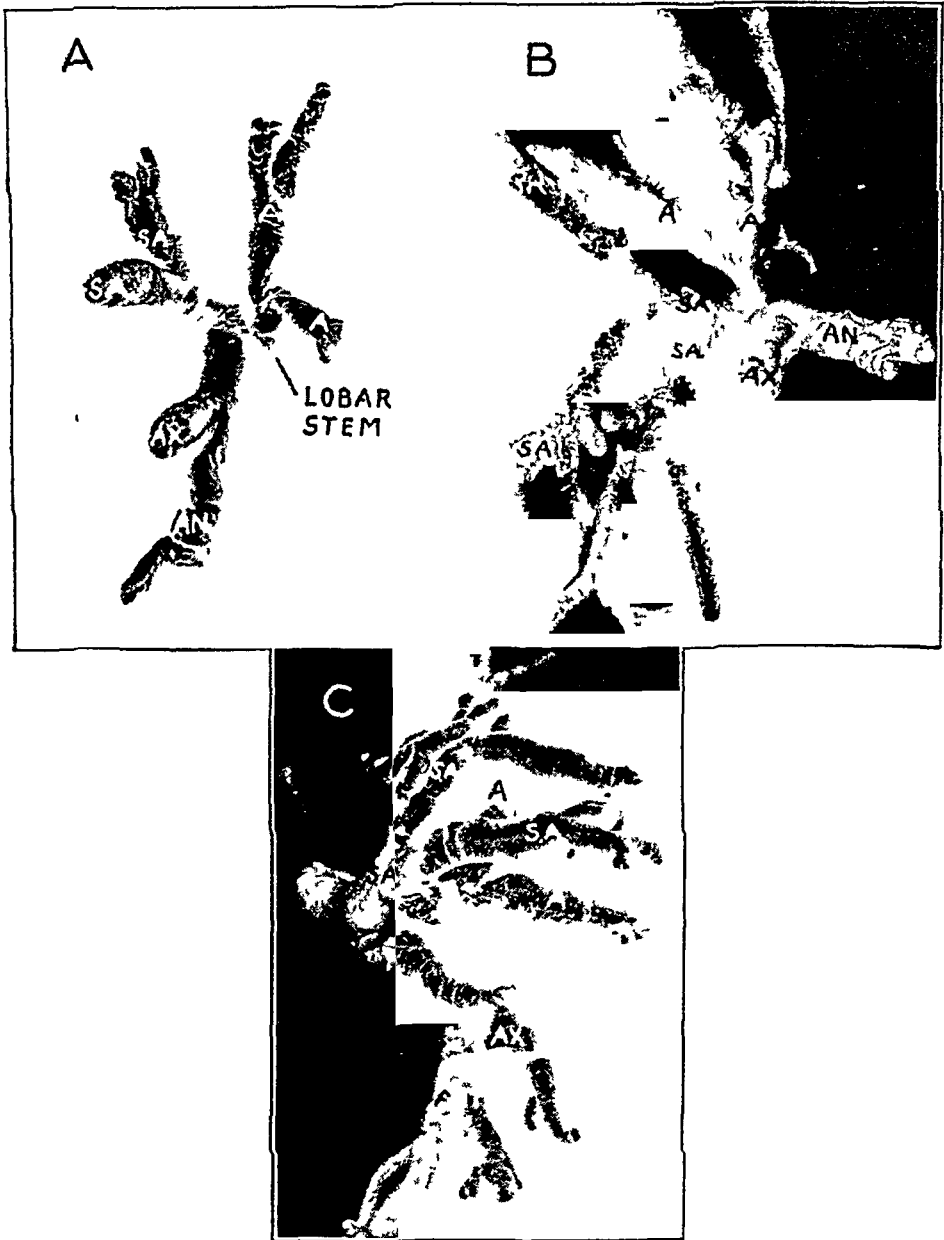


Fig 4—*A*, cast of right upper lobe bronchus in man with the cast tilted to show all the segmental bronchi. The anterior apical branch points anteriorly instead of upward. *B*, anterolateral view, with incomplete filling of the axillary and anterior branches. *C*, inferior posterolateral view. *SA*, signifies subapical branch, *A*, apical branch, *AX*, axillary branch, and *AN* and *ANT*, anterior branch.

We take this opportunity to show an unusual anomaly in the orifices of the bronchial segments of the lower lobe of a human left lung. We show first, for comparison an anterior view of a common specimen

of the lower lobe of the left lung (fig 7 *A*), with the bronchus opened. The figure shows the segmental orifices in their usual position. Figure 7 *B* shows the posterior views of figure 7 *A*, with the segments delineated by inflation. The abnormal lobe (fig 8) was normal in size and shape. When the bronchial stem (fig 8 *A*) was opened, the orifices of the anterior basal and the axillary basal segments were in their usual positions, and inflation revealed their usual distribution, but an orifice for the posterior basal segment was apparently absent. A segmental orifice (2), which is proximal or cephalad to, or above, the level of the anterior basal area in a common position of the orifice of the sub-

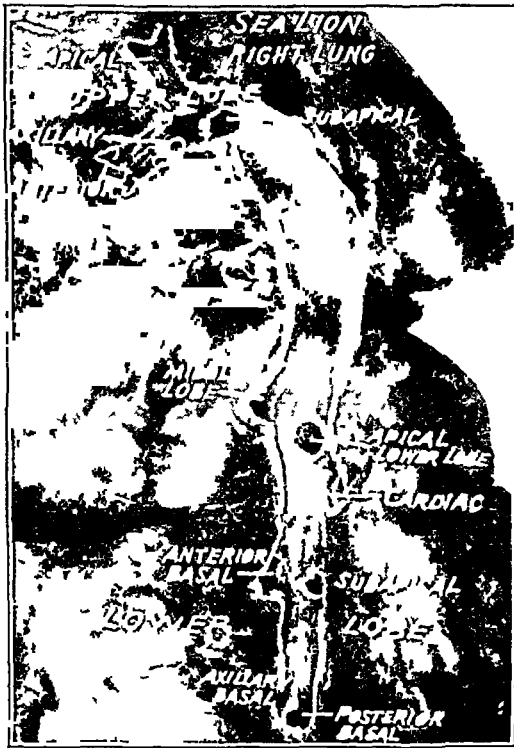


Fig 5—Bronchial tree in the right lung of the sea lion. It is practically similar to that of the human being.

apical bronchus, is seen. On inflation it showed bronchial distribution to the subapical and the posterior basal areas. On opening this segmental orifice (fig 8 *B*), one could see an orifice (2) which on inflation showed (fig 8 *C*) a distribution of bronchi to area 2, or the subapical area. Lower were seen three orifices, marked 4, which were below the level of the anterior basal area and on inflation showed distribution to the normal area of the posterior basal segment (fig 8 *C*). In no specimen, human or other mammalian, have we found the bronchus of the posterior basal segment arising above the level of the bronchus of the

anterior basal segment Aeby's diagram supports our observations Hence we conclude that a fusion of the subapical and posterior basal segmental bronchi must have occurred The reason for the subapical distribution's being shown as lateral, and not posterior, is that the proximal part of this segment on the left side is generally overlain by the

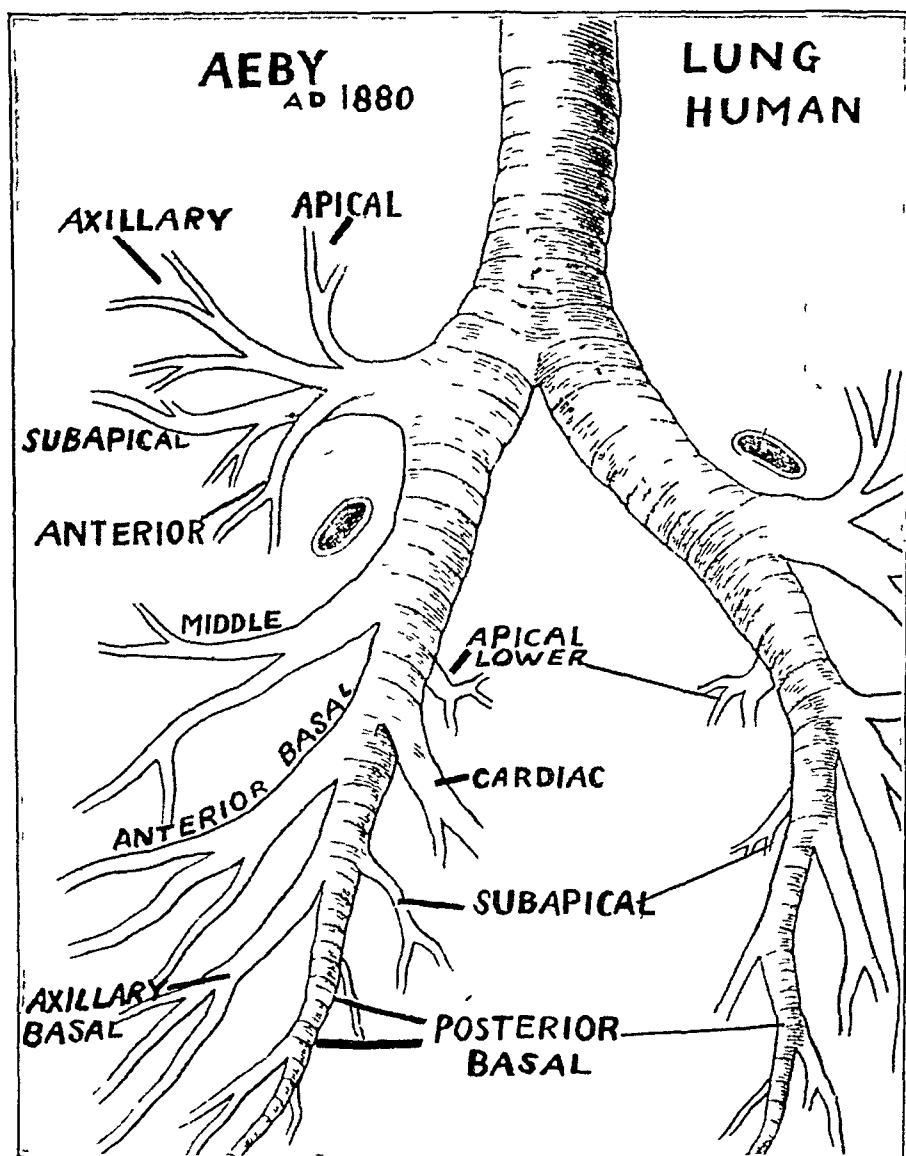


Fig 6—The bronchial tree (Aeby,⁴ with labeling by authors) As the apical branch in the human being has a single trunk more than $\frac{1}{4}$ inch (6 mm) long, before it divides into its two main branches, it is so marked by us The axillary branch is in its usual position The subapical branch shown is smaller than its average size

apical bronchus, above, and the posterior basal bronchus, below, but shows the peripheral part of its segment laterally, as in figure 8 C

In order to convince some contributors to the literature that the anatomy of the lung is not an invariable mold, we show in figure 9 A

a specimen of a human left lung in which the middle lobe is almost separated from the upper lobe. When the bronchial tree was opened (fig 9 *B*), it was found that, instead of the upper and middle lobes' having a common orifice, as they do in most mammals and almost invariably in man, the orifices were definitely separated, as they are in the platypus, which is one of the most primitive of the mammalia. In the same specimen there was an almost complete separation of the mesial, or anterior, part of the anterior basal segment. It was separated more than is shown in the photograph, in fact, it was like a very thick

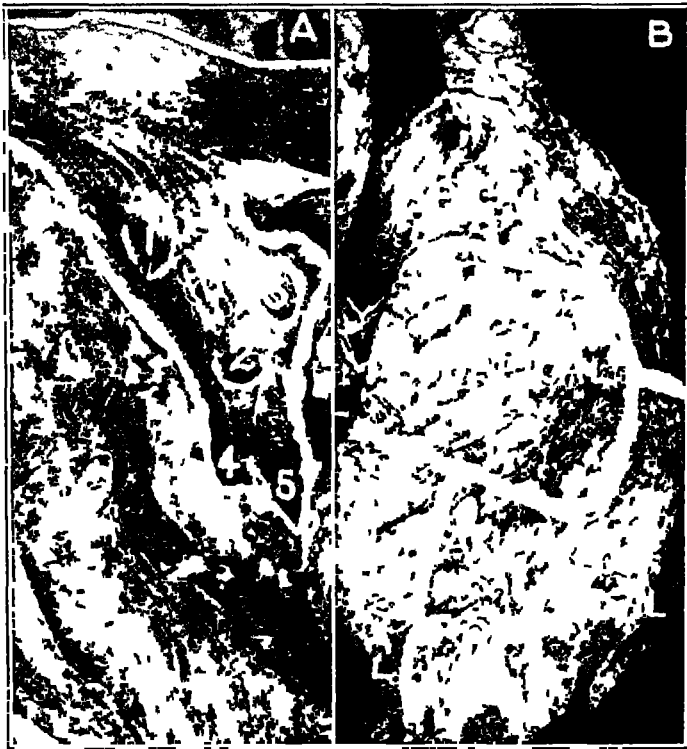


Fig 7—*A*, common type of lower lobe of left lung, bronchus opened, anterior view. *B*, posterior view, lobe segments delineated by inflation. Segmental orifices are numbered as follows: 1, apical, 2, subapical, 3, anterior basal, 4, posterior basal, and 5, axillary basal.

leaf. In the illustration the common segmental orifice is opened, showing the orifices of the mesial part and the posterior and lateral part of the segment. A similar specimen evidently induced a speculating contributor to suggest that it was a homologue of the cardiac, which is usually only on the right side. Deve⁵ of Rouen has shown that in the gibbon and cavy, which have a cardiac lobe on the left side, the lobar bronchus comes off near the apical branch, as would be expected. It may be

⁵ Deve, F. Bull. et mem. Soc. anat. de Paris 78:270 (March) 1903.

noted that the subapical branch has a distribution to the mediastinal, posterior and lateral parts of the lobe

We once more reiterate that the most satisfactory way of demonstrating the bronchopulmonary segments is by using the Moolten⁶ method of fixing the lungs, as by subsequent inflation the segments are sharply delineated. We have given up the making of casts, as they are of little help in the demonstrations to students. Students are at once impressed by inflation of properly fixed specimens and get a sound idea of the topography of the segments, which knowledge is necessary

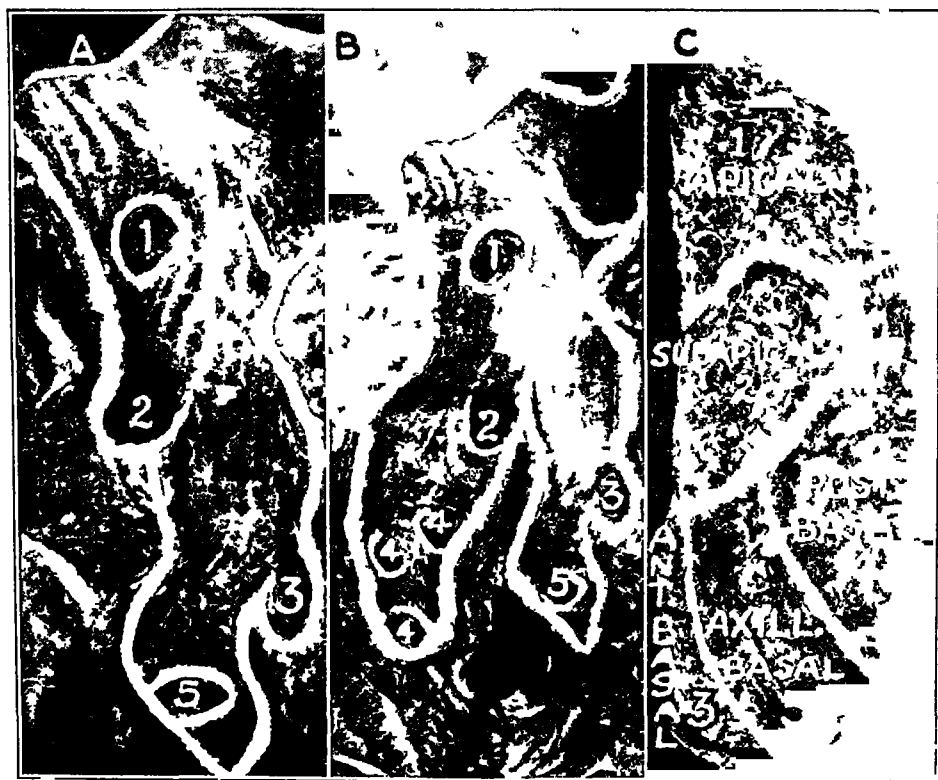


Fig 8—*A*, left lower lobe bronchus opened to show apparent absence of orifice of posterior basal segment. The orifice marked 2 is in the position common for the subapical orifice.

B, segmental orifice marked 2 in *A*, opened out. The orifice marked 2 is so numbered, as on inflation the usual distribution to the subapical area is delineated, orifices numbered 4 on inflation together delineate the distribution of the posterior basal orifices.

C, posterior view, showing the delineation of the bronchopulmonary segments.

in view of the recent development of segmental resection. We have found it practically impossible to get any useful results from the demonstration of fresh lungs in the autopsy room. Fresh lungs will readily burst or develop artificial emphysema by inflation, when apparently

⁶ Moolten, S. E. A Simple Apparatus for Fixation of the Lungs in an Inflated State, *Arch. Path.* 20:77 (July) 1935.

they are just fully expanded. Moreover, when the bronchial stem is opened in its full length, the lung collapses. One author⁷ suggested the insertion of a short piece of rubber catheter plugged into a segmental branch of a fresh specimen and the pumping in of air by a Higginson syringe as the simplest method of demonstration of segments. This will produce an artificial emphysema. Turning over a fresh lung and holding the collapsed, slippery mass in an endeavor to demonstrate by inflation the segmental delineation is worth a trial by any investigator, as it will convince him of the uselessness of a fresh lung for accuracy in delineation.

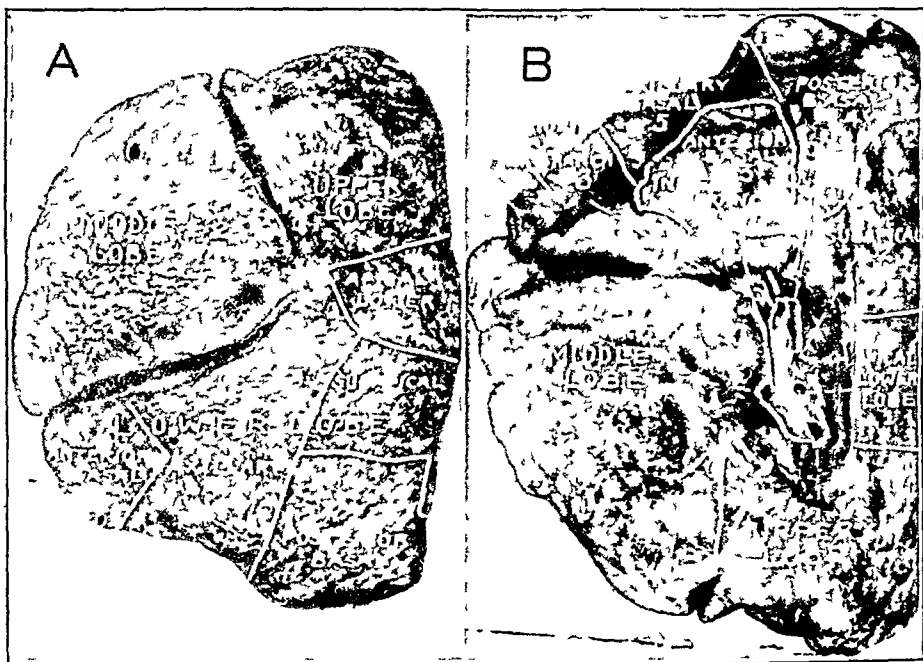


Fig 9—*A*, left lung, showing practical separation of middle from upper lobe. *B*, bronchial tree opened, showing complete separation of the orifice of the upper lobe from that of the middle lobe and almost complete separation of the inner from the outer part of the anterior basal segment. The common orifice is opened to show the orifices of each segment. Note that the subapical segment of the lower lobe has a mediastinal, posterior and lateral distribution.

The Moolten apparatus is cheap and easily constructed. Specimens prepared by this method will last for years without losing their sharp segmental delineation. After the excess of formaldehyde solution U S P (1:8) has been removed, the lung may be filled with, and left in, methylated spirit⁸ for twelve hours, drained and then immersed in preserving fluid⁹ for twenty-four hours. Finally, the preserving fluid

⁷ Foster-Carter, A. F. *Brit J Tuberc* **36** 19, 1942.

⁸ Industrial methylated spirit Br. contains 19 volumes of ethyl alcohol (95 per cent), with 1 volume of methyl alcohol.

⁹ Two hundred grams of sodium arsenate is boiled in 3 liters of water and added to 7 liters of tap water in which 1 Kg. of potassium acetate has been dissolved. To this 2 liters of glycerin is added.

is drained or suctioned out, and the lungs are wrapped in lint moistened with the solution. The addition of merthiolate® (sodium ethylmercurithiosalicylate) or nitromersol N F disinfecting fluid, 1 part to 3 of the preserving fluid, to saturate the moist cloth covering the specimen, will prevent the formation of even a trace of mold, especially if some of the fluid is left in the bottom of the container.

NOTE—At the meeting of the Otolaryngological Section of the Pan-Pacific Surgical Association in Honolulu, in September 1948, when several chest surgeons were present, the terminology of the bronchial tree was discussed. While the separate entity of the axillary segment of the upper lobe was accepted, it was decided that this segment should be given the term lateral, in conformity with modern terminology. Similarly, the segments of the middle lobe should be termed lateral and anterior. In the lower lobe, the subapical segment was accepted as a separate division, but the axillary basal segment should be termed lateral basal.

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EFFECT ON THE EAR OF VITAMIN A FEEDING AFTER SEVERE DEPLETION

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EXPERIMENTAL means of producing bone changes in the otic capsule are limited. One method that has recently been brought into focus is concerned with vitamin A depletion of young animals.

According to Wolbach,¹ vitamin A is one important factor that is specifically concerned with the growth of the bony skeleton of mammals. The peculiar growth sequences in epiphyseal cartilage are arrested in animals depleted of vitamin A. Remodeling of bones of cartilaginous origin in the base of the skull is arrested also. The growth of the calvaria, of membranous origin, which normally increases in area and changes in curvature by resorption in the exterior of the skull and deposition of bone on the interior surface, is also affected. These processes are accelerated but maintain the same pattern with excessive vitamin A feeding, according to Wolbach. Mellanby,² however, expressed the belief that normally this development of skull and vertebrae takes place by osteoclastic absorption of bone of the cranial surface and deposition of new bone on the marrow side. In depleted animals, in his opinion, this sequence is reversed, and osteoblasts are more active on the cranial side of the skull. The interpretation of the temporal bone changes has varied. The picture is one of apparently excessive periosteal bone formation on the inner surface of the temporal bone, involving the internal acoustic meatus. Wolbach expressed the belief that this is not a primary effect but simply the normal rate of formation of periosteal bone for this area. He expressed the belief that throughout the skeleton appositional or periosteal bone formation is not controlled by vitamin A.

Mellanby,³ on the other hand, expressed the opinion that the new periosteal bone is excessive and that this excess is one of the primary

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1 Wolbach, S. B. Vitamin A Deficiency and Excess in Relation to Skeletal Growth (Ludvig Hektoen Lecture), *Proc Inst Med Chicago* **16** 118-145, 1946.

2 Mellanby, E. Croonian Lecture. Nutrition in Relation to Bone Growth and the Nervous System, *Proc Roy Soc, London, s B* **132** 28-46, 1944.

3 Mellanby, E. The Effects of Bone Dysplasia (Overgrowth) on Cranial Nerves in Vitamin A Deficient Animals, *J Physiol* **101** 408-431, 1943.

effects of vitamin A depletion Both he and Wolbach agreed that the arrest of skull growth results in a disproportion between the growing central nervous tissue and the bony cage This leads to pressure effects and herniations Mellanby expressed the belief that the peripheral nerve changes result from bony pressure in the foramina Changes observed in the olfactory, optic, trigeminal and upper cervical nerves have been at least partly explained in this way The neurologic disturbances that were considered as primary effects of vitamin A deficiency were thus explained on the basis of bone overgrowth that not only pinched the nerves on the intracranial side but encroached on the development of the brain stem itself⁴ The reduction of the size of the posterior fossa resulted in an increase of intracranial pressure and a reduction in the amount of fluid and sometimes in an internal hydrocephalus One part of vitamin A (1,000 U S P [or international] units) in 1,500,000 parts of food prevented this general picture of deficiency

A diet rich in calcium produced more compact bone and less cancellous bone both in normal and in depleted animals, but the total amount of bone was still greater in the depleted animals Therefore calcium is not the controlling factor in producing this bony overgrowth

The picture in vitamin A depletion is one of failure to absorb older formed bone to allow for the growth of the central nervous system as well as the laying down of new bone According to Mellanby, in normal animals the growth of the skull cavity is accomplished by abundant osteoclastic activity in the inner surface of the skull Osteoclasts are not seen on this surface in vitamin A-depleted animals They are seen on the marrow side, however This is the reverse of the normal The normal distribution of osteoblasts is similarly reversed

Wolbach and Bessey⁵ expressed the belief that the primary cause of nerve damage is the attempt of the nervous system to grow normally in a stunted bony skull cage, leading to herniations and compressions They did not find narrowing of the spinal canal in the depleted rat The overgrowth of periosteal bone was limited to the otic capsule, and they related it somehow to the fact that the bony labyrinth attains adult size before birth

Mellanby⁶ expressed the opinion that serous labyrinthitis seen in some of his animals was a primary effect of some toxins in the spinal

4 Mellanby, E Lesions of the Central and Peripheral Nervous System Produced in Young Rabbits by Vitamin A Deficiency and a High Cereal Intake, *Brain* **58** 141-173, 1935

5 Wolbach, S B, and Bessey, O A Vitamin A Deficiency and the Nervous System, *Arch Path* **32** 689-722 (Nov) 1941

6 Mellanby, E The Experimental Production of Deafness in Young Animals by Diet, *J Physiol* **94** 380-398 1938

and labyrinthine fluid. Destruction of the end organ itself with precipitation of albuminous material in the labyrinthine spaces was considered as evidence of this. This was in contrast to a good end organ retained



Fig 1 (rabbit 89, left ear)—Vitamin A depletion. New bone (*B*) thickens the internal aspects of the periosteal layer of the otic capsule with some lengthening and narrowing of the internal meatus. The new bone contains islands of vascular connective tissue which appear to have ossified in the reversal experiments. The line of demarcation between the old and the new periosteal bone is rather distinct.

in cases in which degeneration of neurons alone was present. In 1 dog that was depleted and then fed vitamin A, neural degeneration was

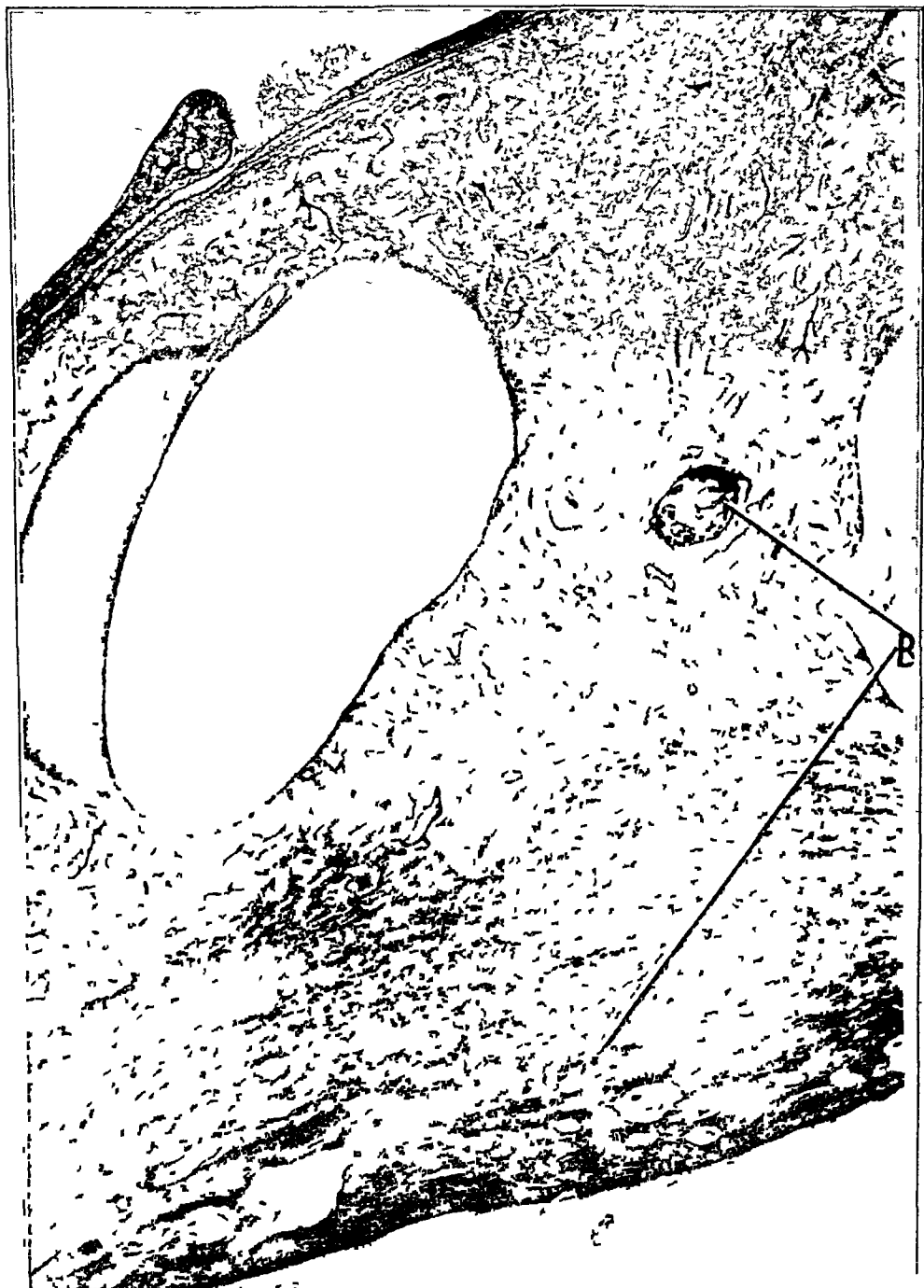


Fig 2 (rabbit 89, left ear) —Vitamin A depletion. Note new bone (*B*) in the cochlear aqueduct and along the posterior aspect of the capsule.

present without damage of the end organ, while the litter mate, without vitamin A, showed both nerve and end organ degeneration. The degree

to which the developed pathologic changes may be changed by feeding vitamin A is not well understood. It seemed indicated to extend the observations previously reported to include experiments in which animals would be depleted and after a suitable period again given vitamin A. This should give information as to the amount of reversal of the primary bone changes and secondary neural changes that can be brought about by vitamin A feeding. Stimuli causing pathologic bone formation are thus followed by stimuli tending to restore bone formation to a normal state.



Fig 3 (rabbit 92, right ear) —Vitamin A depletion. New bone (*B*) with islands of connective tissue is seen against the posterior aspect of the old bone of the capsule and in the internal meatus and against the cavity of the flocculus. The nerve supply of the labyrinth is intact. There is no new bone about the endolymphatic sac and duct (*E*).

The previous observations on the pathologic changes of the temporal bone in vitamin A-depleted young animals confirmed those made by Mellanby, Wolbach and Bessey, Loch⁷ and Covell⁸. The principal

7 Loch, W. E. Changes in the Labyrinth Capsule in Experimental Avitaminosis (A, C, D, E) of Animals, *Monatsschr f Ohrenh* **73** 542-561, 1939.

8 Covell, W. P. Pathologic Changes in the Peripheral Auditory Mechanism Due to Avitaminosis (A, B Complex, C, D and E), *Laryngoscope* **50** 632-647, 1940.

change was in the large amount of new bone formation in the internal acoustic meatus, which caused narrowing and lengthening of the canal and its contained nerves⁹. It was shown that, despite this narrowing of the internal auditory canal, auditory function as tested by the middle ear muscle reflex was not necessarily impaired. The middle ear side of the otic capsule in this first group of animals was not involved in this bony hyperplasia. The new bone was cancellous and had considerable fat marrow and vascular connective tissue spaces. No inflammatory reaction was noted in the bone, and no osteoid tissue was seen in these areas. No tendency toward middle ear inflammation or serous labyrinthitis was observed.

METHOD

Litters of rabbits 8 weeks of age were placed on a diet consisting of 4 parts of oats and 1 part of bran. To this was added 2 per cent "salt mix" to insure an excess of calcium and phosphorus for bone formation. From 40 to 70 Gm (depending on age) of desiccated alfalfa was fed daily to each rabbit. In addition each rabbit received approximately 0.5 cc of Smaco's vitamin B complex^{10a} and 5 drops of synthetic oleovitamin D, U S P (irradiated ergosterol) per day. Two or three times a week they were fed lemon or orange juice or raw peeled white potatoes. The control and the reversed animals received 1 drop (approximately 2,200 units) of Smaco's standardized carotene in cottonseed oil^{10b} per day. The alfalfa meal used in the diet was heated in an oven at 120 C for forty-eight hours to destroy the carotenoid pigment or precursors of vitamin A. Various samples were assayed according to the method of Peter and proved to be free of carotenoid pigment.

Observations of cochlear function were made by use of the middle ear muscle reflex.

Normal controls, depleted animals and animals depleted and then fed vitamin A were studied. The previous observations on depleted animals served as a guide in determining when to resume vitamin feedings.

RESULTS

The question was whether the pathologic changes in the temporal bone brought about by vitamin A depletion could be reversed by vitamin A feeding.

While control animals doubled their weight in about five months, the vitamin A-depleted animals failed to gain weight, lost weight or showed a much smaller increase in weight than the controls. About five months was needed to produce gross corneal changes. By this

9 Perlman, H. B., and Willard, J. The Ear in Experimental Vitamin A Deficiency, *Ann Otol, Rhin & Laryng* 50 349-363 (June) 1941.

10 (a) Smaco vitamin B complex, supplied by Wyeth, Incorporated, Philadelphia, is described as follows. Each 4 cc teaspoon contains thiamine hydrochloride, 1 mg, riboflavin, 1 mg, niacin, 5 mg, pyridoxine, 0.4 mg, pantothenic acid, 0.64 mg, with other vitamin B complex factors natural to rice bran.

(b) Smaco's standardized carotene in cottonseed oil contains 7,500 units of provitamin A per gram.

time the animal was in such poor general condition that death sometimes ensued even if vitamin A feeding had been resumed. A number of

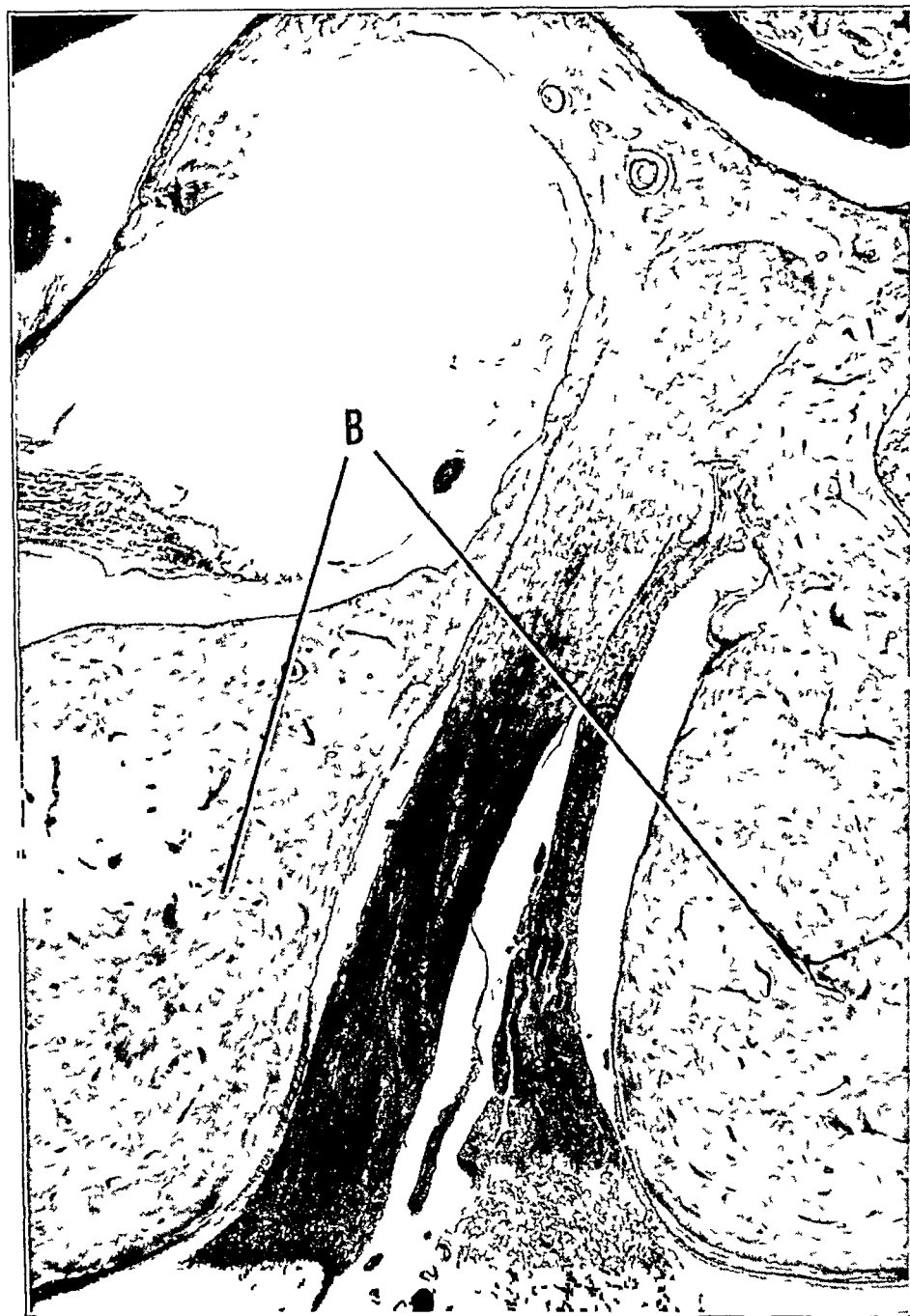


Fig. 4 (rabbit 90, right internal meatus)—Vitamin A reversal. The elongation of the meatus and the contained cochlear and vestibular nerve fibers is shown. The capsular bone is greatly thickened (*B*), but no connective tissue or fat marrow spaces are seen. There is no cement line of demarcation between the old bone and the newly proliferated bone of the capsule suggesting extensive reorganization of the capsule.

animals were therefore depleted for a shorter period before vitamin A feeding was resumed, in order that they might be carried for a long enough period to allow for any possible reversal of the histologic changes previously described in the temporal bone.

In the group of animals fed a depleted diet for five months or until the animal died, new bone formation was uniformly obtained on the intracranial aspect of the temporal bone (fig 1) with and without degenerative changes in the eighth nerve fibers and ganglion cells. New bone was also seen narrowing the cochlear aqueduct (fig 2), but none was noted in relation to the endolymphatic duct or sac (fig 3). No



Fig 5 (rabbit 90, right ear)—Vitamin A reversal. Note extensive reorganization of bone of the labyrinthine capsule (*B*), also hypertrophy of the posterior surface and plugging of the internal meatus with degeneration of the neural elements. There are no signs of labyrinthitis.

evidence of serous labyrinthitis was seen. In the animals that were depleted and then fed vitamin A no reversal of this new bone formation was observed. The bone became more compact, and the large islands of vascular connective tissue were replaced by compact bone. The degenerative changes in the nerve fibers and ganglion cells were also not reversed. The latter change would not be expected once a clearcut degeneration of nerve tissue had occurred.



Fig 6 (rabbit 90, right ear) —Vitamin A reversal. Widespread degeneration of cochlear nerve and ganglion, along with appearance of nodules of new bone (*B*) in the cribriform area and in the scala tympani. The periosteal and the enchondral bone are reorganized by dense bone, and there is hypertrophy of the posterior or intracranial layer. The nodules of new bone in the cribriform area probably encroach on the cochlear nerve and its vascular supply.



Fig 7 (rabbit 81, right ear)—Vitamin A reversal. Note the plug of bone (*B*) encroaching on the vestibular side of the internal acoustic meatus. The meatus is elongated by newly proliferated periosteal capsular bone (*B*), clearly defined from the old periosteal capsule. The light-staining islands represent solid bone filling the connective tissue and marrow spaces seen in animals killed at the height of vitamin A depletion.

Aberle¹¹ showed that paralysis, while it could be prevented with carotene or cod liver oil, could not be cured, although treatment restored a normal rate of growth

Wolbach and Bessey prevented paralysis by resuming vitamin A feedings seven to ten days before symptoms were expected After onset of paralysis no improvement was obtained with vitamin A feedings

Setterfield and Sutton¹² could detect myelin changes with ultra-violet rays three to six days before symptoms appeared At this time vitamin A feedings arrested the nerve change

A protocol of a reversal experiment shows that the animal was placed on the depleted diet in February One month later the left bulla was opened, and the threshold of the acoustic middle ear muscle reflex was determined A good response was obtained Four months after the onset of the experiment the animal's weight was only 1.79 Kg, compared with 1.24 Kg at the beginning of the vitamin A depletion Eight months after the onset of vitamin A feeding definite corneal changes were evident along with weakness of the extremities, and the animal began to lose weight, 1 drop of standard carotene (approximately 2,200 units of vitamin A) was now given daily The loss of weight was made up When the animal showed corneal signs (eight months after the onset of the experiment), the bulla was again opened, and now there was no acoustic response of the middle ear muscle Vitamin A feedings were continued for five months at the end of which time the animal's weight was 2.10 Kg At this time both bullas were opened, and no acoustic response of the middle ear muscles could be elicited The animal was killed thirteen months after the beginning of the experiment and the temporal bones were removed for sectioning (figs 4, 5 and 6)

The protocol of another rabbit indicates an initial weight of 1.31 Kg Depletion began in January, at which time the auditory threshold was established by exposure of the left middle ear muscles After four months of depletion the weight was only 1.60 Kg, and two weeks later the weight had dropped to 1.53 Kg The left bulla was opened eight months after the beginning of the experiment and was found to be filled with pus The right middle ear was free of infection, however, and the auditory threshold was found to be a little impaired as compared with the initial values Vitamin A feedings were now resumed and continued four months At the end of this time, one year after the onset of the experiment, the animal's weight was 1.9 Kg, and the bulla was opened for auditory tests There was no pus in the left middle ear, but the tensor tendon did not contract The right bulla was free of infection, and the auditory function was determined by observing the stapedius muscle reflex Good function was found The animal was killed one year after the onset of the experiment, and the temporal bones were removed for sectioning (figs 7, 8 and 9)

11 Aberle, S B D Neurological Disturbances in Rats Reared on Diets Deficient in Vitamin A, *J Nutrition* 7 445-461, 1934

12 Setterfield, H E, and Sutton, T S The Use of Polarized Light in the Study of Myelin Degeneration Degeneration of Myelinated Nerves in Avitaminosis A in White Rat, *J Nutrition* 9 645-655, 1935



Fig 8 (rabbit 81, right ear)—Vitamin A reversal. Note the new bone (B) in the internal meatus and along the posterior fossa. The neural elements of the cochlea are partially degenerated. There is no serous labyrinthitis. Islands of light-staining bone are probably the result of ossification of earlier connective tissue islands. The cement line (C) between the old and the new bone of the capsule is distinct.

In another animal vitamin A feeding was started after four months of depletion. The weight was now only 1.15 Kg, as compared with 0.99 Kg at the onset of the experiment. Hearing was good at the onset and was retained when tested after this four months of depletion.

Vitamin A feedings were then begun and were continued for six months, when the weight had increased to 2.05 Kg but shortly thereafter evidence of labyrinthitis developed, with rotatory nystagmus and rotation of the head to the right. Both bullas were found to be filled with pus. The animal was put to death, and the temporal bones were removed for section.

As observed in a previous report, vitamin A depletion per se is compatible with good auditory function in man, and in the experimental



Fig. 9 (rabbit 81, left ear)—Vitamin A reversal. Note the large plug of bone (B) filling the internal meatus, with thickening of the periosteal layer by dense bone free of connective tissue islands.

animal as tested by the middle ear muscle reflex. Even when considerable new bone formation is present in the internal acoustic meatus of a depleted animal good function may continue. Impairment of auditory function appears to be secondary to severe compression of the nerve and its vascular supply by new bone in the internal meatus, resulting in widespread degenerative changes.

Labyrinthitis does not appear to be a primary effect of vitamin A deficiency. Serous labyrinthitis, as observed by Mellanby, might be

caused by circulatory changes associated with severe bony occlusion of the internal meatus. Suppurative labyrinthitis is secondary to middle ear infection. The amount of new bone formation on the inner aspect of the temporal bone remained essentially unchanged even after six months of vitamin feeding. Only the character of the new bone was changed. The bone became more compact as the many large vascular connective tissue spaces were replaced by bone. Secondary changes in the neural elements of the eighth nerve also showed no signs of reversal.

In addition to bony changes on the posterior fossa aspect of the temporal bone there are definite changes throughout the temporal bone,

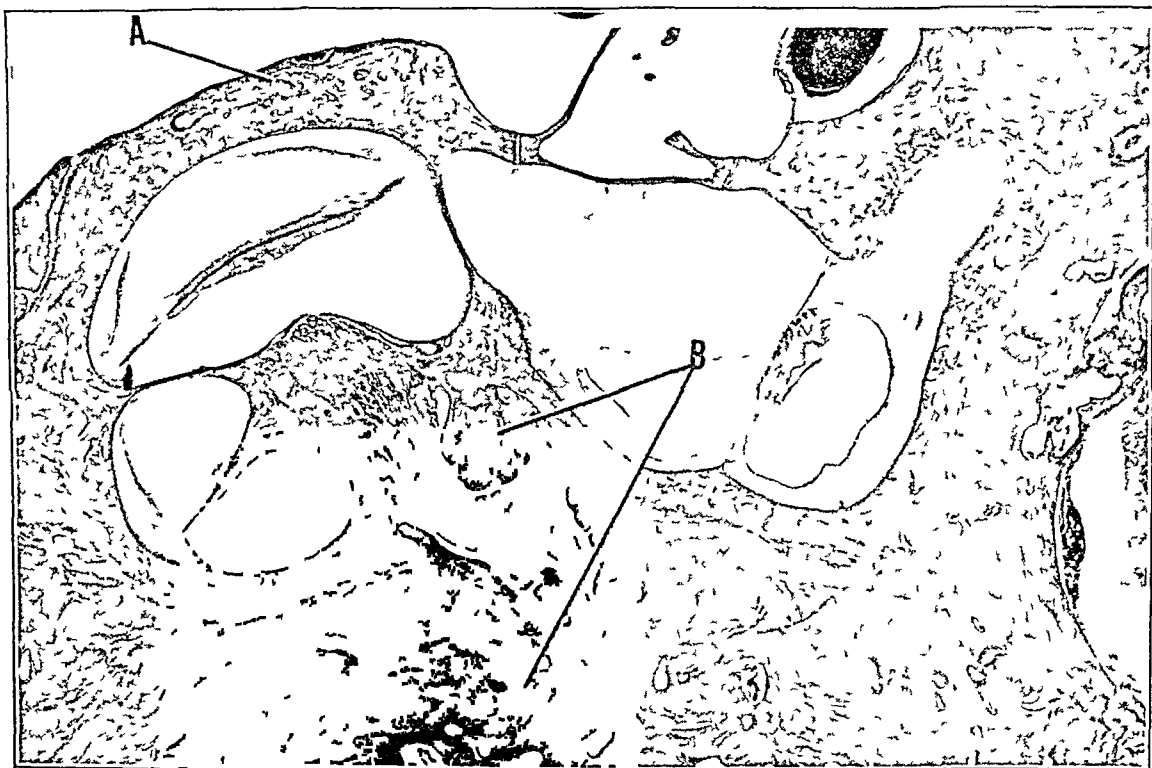


Fig 10 (rabbit 91, right ear)—Vitamin A depletion. Note the large amount of new bone (B) on the posterior aspect of the capsule and the evidence of activity of the capsule on the middle ear side, where islands of vascular connective tissue are seen (A).

bullae wall, promontory (fig 10) and external canal, consisting primarily in islands or buds of vascular connective tissue. These appear to be invading the old bone of the capsule but are not lined by multinuclear osteoclasts but rather by single nucleated cells resembling osteoblasts but without the apposition of osteoid. In the reversed experiments these islands are replaced by bone which on the promontory side of the capsule is not associated with a definite thickening. These buds of vascular connective tissue are not normally found in these regions in

the numbers that they occur in the bulla or the external canal wall in the vitamin A-depleted animals and not at all in the capsule bone of the promontory. In this area their appearance suggests that the old bone of the capsule has been removed, even in the endochondral layer. The changes seen resemble those of inflammation or hyperemia in bone. The regularly arranged flat layers of new bone on the smooth posterior aspect of the capsule and the rounded nodules of new bone at the cribriform area of the eighth nerve appear to be formed through some other process than the intervention of these scattered vascular connective tissue buds. In the promontory they seem to arise around preformed blood vessel spaces. In the reversed experiments they are replaced by mature and stable-looking compact bone.

A similar picture of periosteal and endochondral capsule bone absorption by vascular connective tissue buds limited to the semi-circular canal area appeared in the experiments of Krainz¹³ and resulted from acidosis. Sonoda¹⁴ also produced bone changes by tying off the vertebral and the carotid artery to the area in guinea pigs. Encroachment of the bony overgrowth on the vascular supply to the temporal bone perhaps explains the pathologic conditions seen in these depleted animals, but no evidence of dissolution of the bony overgrowth was noted in the reversal experiments. Furthermore, large numbers of osteoclasts were seen in Sonoda's cases, but none were found in these vitamin A-depleted animals. Some independent factor would have to be considered.

SUMMARY

The remodeling of the skull to accommodate the growing nerve tissue within it is controlled in part by the action of vitamin A. This remodeling occurs both in the calvaria and in the cartilaginous bones of the base of the skull. On the other hand, the structures of the inner ear are fully grown at birth, so that continued remodeling of the inner layers of the otic capsule that surround it is unnecessary. Therefore these layers are normally inactive. However, as the skull grows in thickness and density the outer periosteal layer of the otic capsule takes part in this growth. While this is true in a general way for very young animals, increase in thickness of the cranial aspect of the periosteal capsule is not normally seen between the limits of the age period of the animals used in this study (8 weeks and 1 year). A definite, absolute thickening of this part of the periosteal capsule is seen in the depleted animals of this age period. Furthermore, bony nodules

13 Krainz, W. Changes in the Labyrinth Capsule of Guinea Pigs by Acidosis, *Ztschr f Hals-, Nasen- u Ohrenh* **34** 170-174, 1933

14 Sonoda, S. Experimental Studies of the Pathology of Chronic Anemia of the Labyrinth, *Mitt a d med Akad zu Kyoto* **12** 953-1009, 1934

in the cribriform plate, the cochlear aqueduct and even in the modiolus within the cochlea may be found in the depleted animals. This is not to be explained on the basis of the continued operation of an unaffected growth process. The activity in the middle ear side of the otic capsule seen in some of these animals is also not observed as part of the growth pattern of this bone in this age period.

Vitamin A feeding after depletion does not restore the labyrinthine capsule to a normal state. The excess of periosteal bone on the internal surface remains, with the resulting narrowing and elongation of the internal acoustic meatus. Vitamin A depletion also affects the enchondral layer through activity about the vascular spaces. The vascular connective tissue spaces in the new periosteal bone and in the old enchondral bone become ossified and relatively inactive when vitamin A is restored to the diet. Changes within the labyrinth appear to be secondary to compression of the structures in the internal meatus by the new bone formation. Considerable compression of the cochlear nerve is compatible with good auditory function as tested by the acoustic middle ear muscle reflex. Nerve degeneration caused by bony compression cannot be reversed by feeding vitamin A.

The experimentally produced pathologic change of the temporal bone is important for one's understanding of the factors needed for normal development of the otic capsule. This particular type of pathologic change, however, is rarely encountered in the human subject and has not been reported in known vitamin A deficiency states in man. However, old pathologic reports by Moose and Steinbrugge,¹⁵ Flesch¹⁶ and Manasse¹⁷ describe findings in the human temporal bone resembling those seen in experimental vitamin A depletion. A recent description of similar pathologic observations, including functional tests, was given by Gerlings¹⁸ in regard to the condition known as oxycephaly. He pointed out the similarity between the bony changes occurring about the internal meatus in this condition and those observed by Mellanby in vitamin A-depleted dogs.

15 Moose, S., and Steinbrugge. Hyperostosis and Exostosis, *Ztschr f Ohrenh* **11** 48-51, 1882.

16 Flesch, M. Stenosis of Internal Meatus by Cranial Hyperostosis, *Arch f Ohrenh* **18** 66-68, 1881-1882.

17 Manasse, P. Exostoses in the Internal Acoustic Meatus, *Verhandl d deutsch otol Gesellsch* **17** 185-188, 1908.

18 Gerlings, P. G. Clinical and Histopathological Investigations of the Labyrinth in Oxycephaly, *Acta oto-laryng* **35** 91-107, 1947.

SUSPENSION MECHANISM OF THE UPPER LIP AND THE COLUMELLA

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IT IS generally known that the movements of the upper lip play an important role in facial expression. In order to eat, breathe, suck, speak, sing, whisper, whistle, laugh or cry the lips have to be brought into a special position. The nasal tip and the columella are frequently involved in those movements. It so happens that a pleasant smile may change an apparently straight nose into a nose with a slight convexity.

It is not the purpose of this paper to describe the muscular arrangement of such movements. The problem in question is the study of the mechanism of the suspension of the upper lip, because interference with this mechanism is the main danger of surgical treatment of the columella.

ANATOMY

Figure 1 shows the contour of the columella (*A*), the nasolabial angle (*B*) and the philtrum of the upper lip (*C*). The septum mobile (*D*) presents its triangular shape with the base at the nasal dorsum and the apex at the nasolabial angle. One can notice the crescent-shaped curve of the outline of the septal cartilage (*E*) from the nasal dorsum to the anterior nasal spine (*F*) (Griesman¹). The nasolabial angle represents the point of closest approximation of the columella to the curvature of the septal cartilage. At this point one can easily feel with a finger the septal cartilage. From there the arch of the cartilage turns almost horizontally toward the anterior nasal spine. Furthermore, figure 1 shows the vestibulum oris (*G*) and the fornix (*H*) of the alveolobuccal mucosa. It seems important to emphasize that the septal cartilage forms the cranial border of the mass of the upper lip.

Figure 2 illustrates the lines (*a-b* and *c-d*) along which the mucosa of the lips and cheeks is attached to the bones of the face (Merkel²). The points *e* and *e'* indicate the spots where the cheeks move medially when the lips are pushed forward.

1 Griesman, B. L. Effect of a Typical Nasal Plastic Correction on Facial Expression, *Arch. Otolaryng.* **46**: 624 (Nov.) 1947.

2 Merkel, C. L. Anatomie und Physiologie des menschlichen Stimm- und Sprach Organs (Anthropophonik), Leipzig, A. Abel, 1863, p. 246.

As can be seen, the upper lip is suspended along a slightly more curved line than the almost horizontal line of fixation of the lower lip. The curve consists of two lateral elevations and a depression just at the nasolabial angle.

Langer³ plotted the lines of tension of the skin on the human cadaver by making holes in the skin with a round awl and noting the direction of elongation of these holes. Operative incisions should be made, if possible, in the proper lines of tension of the skin (Webster⁴). The lines of Langer represent the lines of normal tension of the skin. The elastic tissue of the corium throws the papillary layer into definite folds which cause these patterns. The epithelium plays no part in the formation of the folds, as it merely covers the corium beneath. These pat-

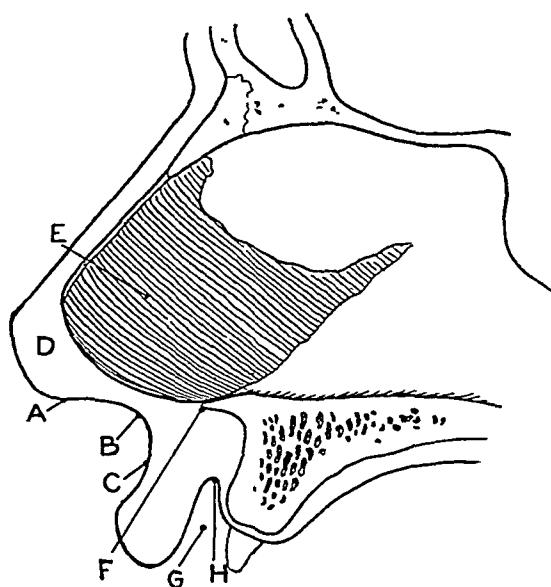


Fig. 1—Note columella (A), nasolabial angle (B), philtrum (C), septum mobile (D), the septal cartilage (E) with its crescent-shaped caudal borderline, anterior nasal spine (F), vestibulum oris (G) and fornix (H).

terns are practically uniform, with only minor individual variations (Davis and Kitlowski⁵).

Figure 3 demonstrates that the tension lines of the columella plotted by Langer seem to run horizontally. However, there is no such distinct tension of the skin visible at the nasolabial angle as is clearly marked along the nasolabial fold.

3 Langer, K. Zur Anatomie und Physiologie der Haut, Sitzungsber. d. k. Akad. d. Wissensch. Math.-naturw. Cl. 45:223, 1861.

4 Webster, J. P., in Christopher, F. A Textbook of Surgery, ed. 4, Philadelphia, W. B. Saunders Company, 1945, p. 1376.

5 Davis, J. S., and Kitlowski, E. A. Immediate Contraction of Cutaneous Grafts and Its Cause, Arch. Surg. 23:954 (Dec.) 1931.

The philtrum or median groove of the upper lip is the region where during ontogenetic evolution both median nasal processes are fused together. Their line of fusion appears disentangled from any marked tension. This fact may help to explain the facility and smoothness of the movements of the upper lip during the production of sound and during facial expression.

The design of the Langer tension lines of the skin of the columella and the philtrum appears to have its analogue in the structure of the mucous membrane of the upper lip (Benninghoff⁶).

Figure 4 shows the horizontal lines of stress along the ridge of the vestibulum oris. There are longitudinal lines running into the mucosa of the cheeks vertical to the border of the upper lip. The picture of the

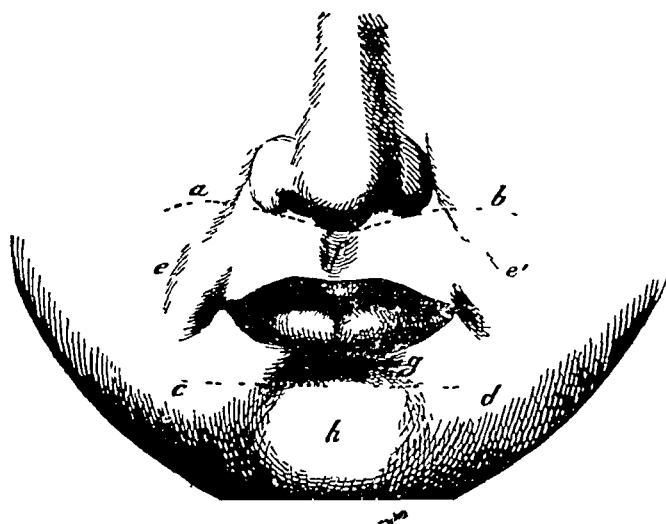


Fig. 2—The long lines *a-b* and *c-d* demonstrate the lines where the lips are attached to the bones of the jaws. *f* is the philtrum, *g*, the chin-lip sulcus, *h*, the chin, *e* and *e'*, the spots of movements of the cheek when the lips are pushed forward.

tension lines of the mucosa are the reversed image of the tension lines of the skin of the upper lip.

When the upper lip hangs down inactively, like a curtain, all the forces acting on the philtrum are balanced by equal and opposite forces. Consequently, there is no tension of skin at the philtrum. The philtrum is in a condition of equilibrium.

However, the real shifting mechanism of this anatomic region will be completely understood only by studying figure 5. Here a median section through the upper lip and the hard palate is demonstrated. A hook is placed into the lower free end of the upper lip and the lip drawn

⁶ Benninghoff, A. Die Architektur der Kiefer und ihrer Weichteilbedeckung, Parodontium 6 50, 1934.

away from the teeth in order to open the fornix. One can see the vestibulum oris, the fornix, the manner in which the mucous membrane is attached to the gum of the alveolus. There is a complex system of criss-crossing fibers running at an acute angle from the gum to the anterior nasal spine and to the cranial border of the upper lip. There are similar fibers running from the fornix to the alveolar bone and from the bone to the spine and to the vestibulum. Above the arch of the vestibulum the intersection of these fibers is clearly visible.

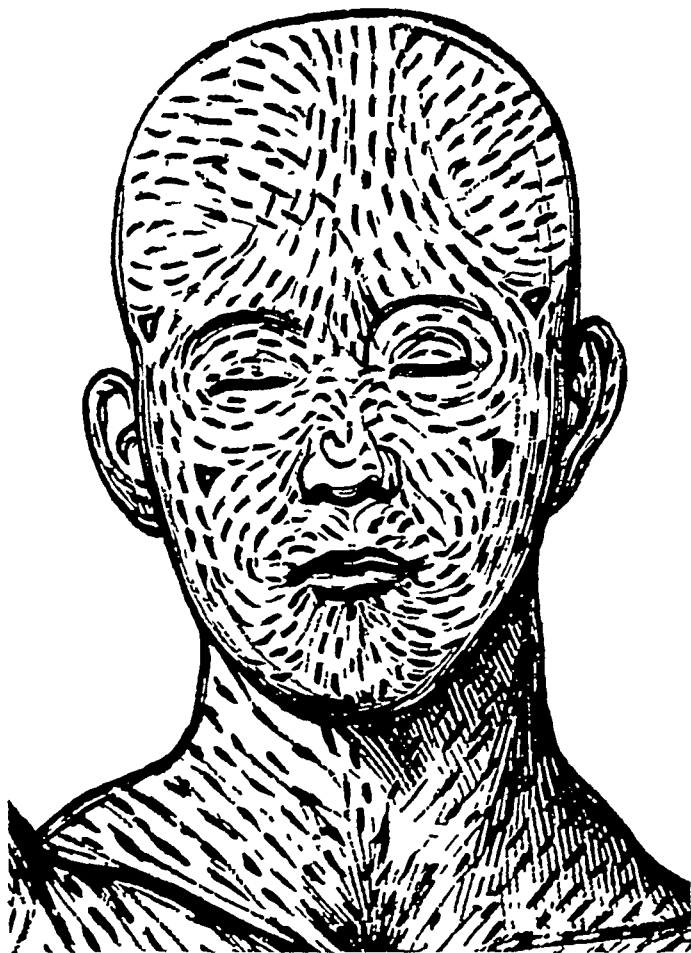


Fig. 3—Langer's lines of tension of the skin. Note the distinct pattern of tension along the nasolabial folds and, in contrast, the absence of tension in the region of the philtrum.

This special arrangement apparently serves the function of the columella and the upper lip. It makes possible the shifting of the tissues by an unobstructed suspension of the arch of the vestibulum. One cannot consider this arch as a stable, inflexible formation, on the contrary, it is especially constructed to yield to the necessity of changing its shape. The raising and lowering, the bending and stretching and the forward

and backward movements of the upper lip and of the columella during the continuously changing configuration of the mouth are thus guaranteed

A similar technical device is in practical use in the so-called extension brackets to bring forward a telephone or electric light equipment from a wall

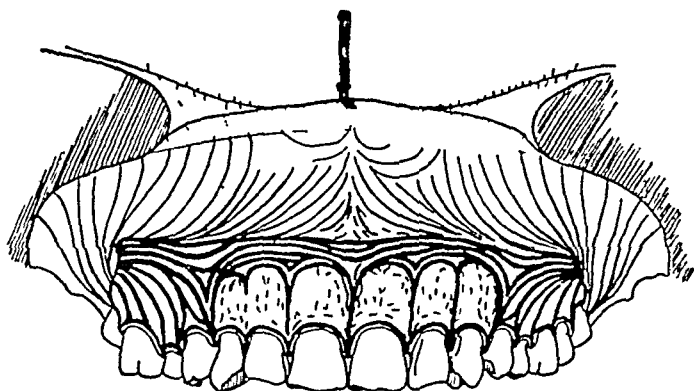


FIG 4—The lines of tension of the mucosa of the upper lip, which appear like the reversed picture of the lines of tension of the skin

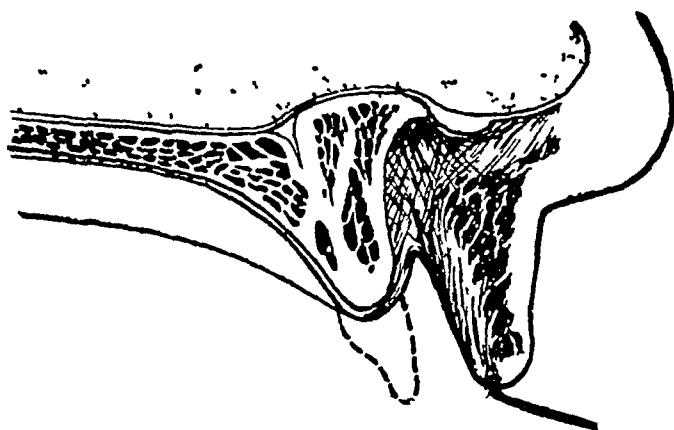


FIG 5—A median section of the upper lip and hard palate. A hook placed in the lip draws the lip away from the teeth to show the fibrous mechanism by which the upper lip is suspended on the anterior nasal spine and the bone of the upper jaw. The fibers are arranged in an extension-bracket-like manner.

SURGERY

Deformities of the columella are often combined with other malformations of the nose. A columella may be either too short, too long, too wide or even deflected. Lengthening or shortening of the columella is frequently interrelated with shortening or lengthening of the upper lip. The size of the base of the columella can be reduced with or without advancing and with or without reducing the tip of the nose.

Several operations have been devised for the correction of such deformities. One of the best known methods is Gensoul's operation for reducing a thickened columella and advancing the point of the nose. Gensoul makes a deep incision from the floor of each nostril downward and inward at the outside of the nose, the two incisions meeting at a point just below the union of the columella and the upper lip and forming a V. The tissues are loosened, the nose is drawn forward and the wound is sutured in the shape of a Y. The columella itself is narrowed by the removal of an ellipse of outside skin of underlying tissue, and the skin is sutured.

The main objection to this and other methods is the visibility of the external scar that follows the outside incisions.

To avoid a visible external scar I recommend the following intra-nasal procedure.

With a Bard-Parker knife, no 11, the aponeurosis connecting the upper and lower lateral cartilages is incised from the center of the plica vestibuli to the dorsum of the septum in both sides. The soft structures are separated in a plane below the perichondrium of the upper lateral cartilage with a doubled-edged Joseph knife.

A Bard-Parker knife, no 15, is introduced through the right intercartilaginous incision, and with the index finger of the left hand in the left nostril as a guide, the mucous membrane of the right side is cut along the caudal margin of the septal cartilage without dividing the membranous septum. The incision is carried to the floor of the nose along the septal borderline toward the anterior nasal spine (fig 6A).

The purpose of this procedure is to procure the exact line of division between the caudal end of the cartilaginous septum and the membranous septum. Thereafter, the button end knife is introduced through the right intercartilaginous incision, advanced across the dorsum until its tip appears through the intercartilaginous incision in the opposite vestibule. The knife follows the line of the former mucosal incision and separates the membranous septum along the caudal end of the cartilaginous septum. The use of the button end knife is limited to a line where the knife touches the skin of the nostrils (*a* and *b* in fig 6B).

With bent scissors directed around the crescent circumference of the septal cartilage toward the nasal spine the membranous septum and the nasolabial angle are completely separated (fig 6C). This method seems to separate the upper lip from the septum without disturbing the important shifting mechanism above the fornix vestibuli oris.

On each side an additional small incision can be made on the floor of the vestibule along the anterior nasal spine in order to free the upper lip completely.

Occasionally it is necessary to thin the base of the columella. For this purpose the connective tissue beneath the surface of the vestibular skin is grasped with a forceps and cut with a knife or with small scissors. Utmost care should be exercised not to trim vestibular skin because of the danger of atresia of the nostrils.

The histologic examination of 6 pieces taken from the base of the columella of 6 different patients revealed that the removed tissue is rich in blood vessels and nerves. Some striated muscle fibers and islands of adipose tissue were found. Most pieces contained some squamous stratified epithelium.

The free mobilization of the columella and of the nasolabial angle can now be readily demonstrated by bringing a hook into the nasal tip and drawing the nose upward. The opposite effect can be achieved by drawing the lip caudally. The nasolabial angle can be shifted according to the wishes of the operator. To effect this, the columella is grasped with a forceps near the point at which it joins the upper lip and can be held in any desired place by suturing. Either a mattress suture made through the whole columella and through the entire thickness of the septal cartilage, including the mucous membrane, may be employed, or a submerged suture (Aufrecht⁷) to form the nasolabial angle can be applied.

Just as it may frequently be necessary to shorten the nasal septum and the anterior nasal spine with the chisel or the biting forceps, so it

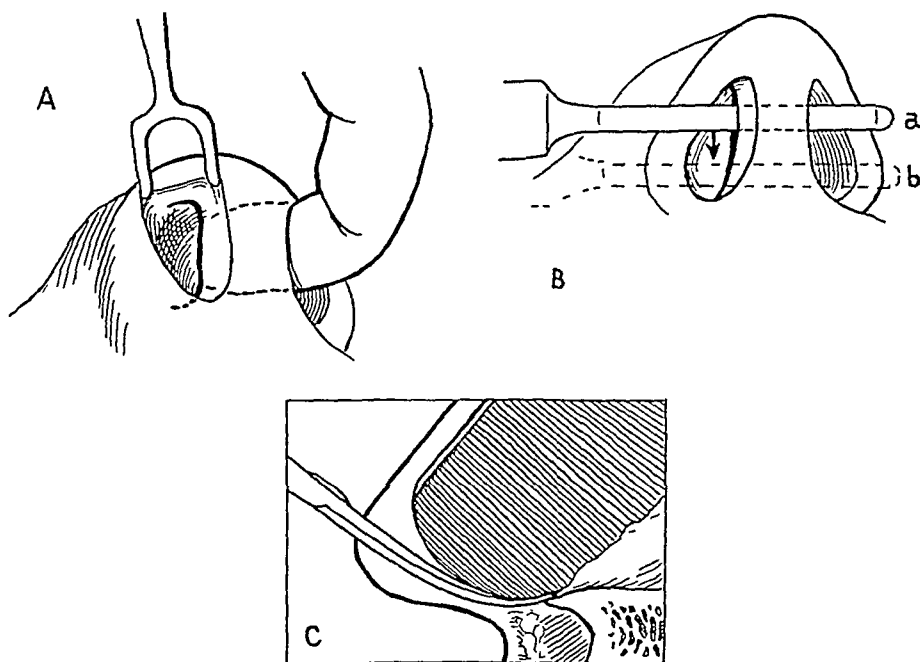


Fig 6—Intranasal procedure for correcting deformity of the columella. In *A* the left index finger is introduced into the left nostril. The membranous septum is bent over to the opposite side. Without dividing the membranous septum, an incision is carried to the floor of the nose along the septal borderline toward the anterior nasal spine.

B shows the button end knife (*a*) being used to separate the membranous septum along the caudal end of the cartilaginous septum, *b* illustrates the limit of the use of the button end knife where it touches the skin of the nostrils.

C demonstrates the use of the bent scissors to separate the membranous septum and the nasolabial angle completely.

may occasionally become necessary to lengthen the septal cartilage and the anterior nasal spine by a cartilaginous graft.

Figure 7 *A* shows the profile of a patient with a slight hump of the bony vault, a saddle of the upper cartilaginous vault, a deformity of the

⁷ Aufrecht, G. A. A Few Hints and Surgical Details in Rhinoplasty, *Laryngoscope*, 53 317, 1943.

nasal tip and an acute nasolabial angle. The tip of the nose had little support. The columella had a convex outline.

B shows the same patient after two stage reconstruction in which several cartilaginous grafts were made. A small oval piece of cartilage

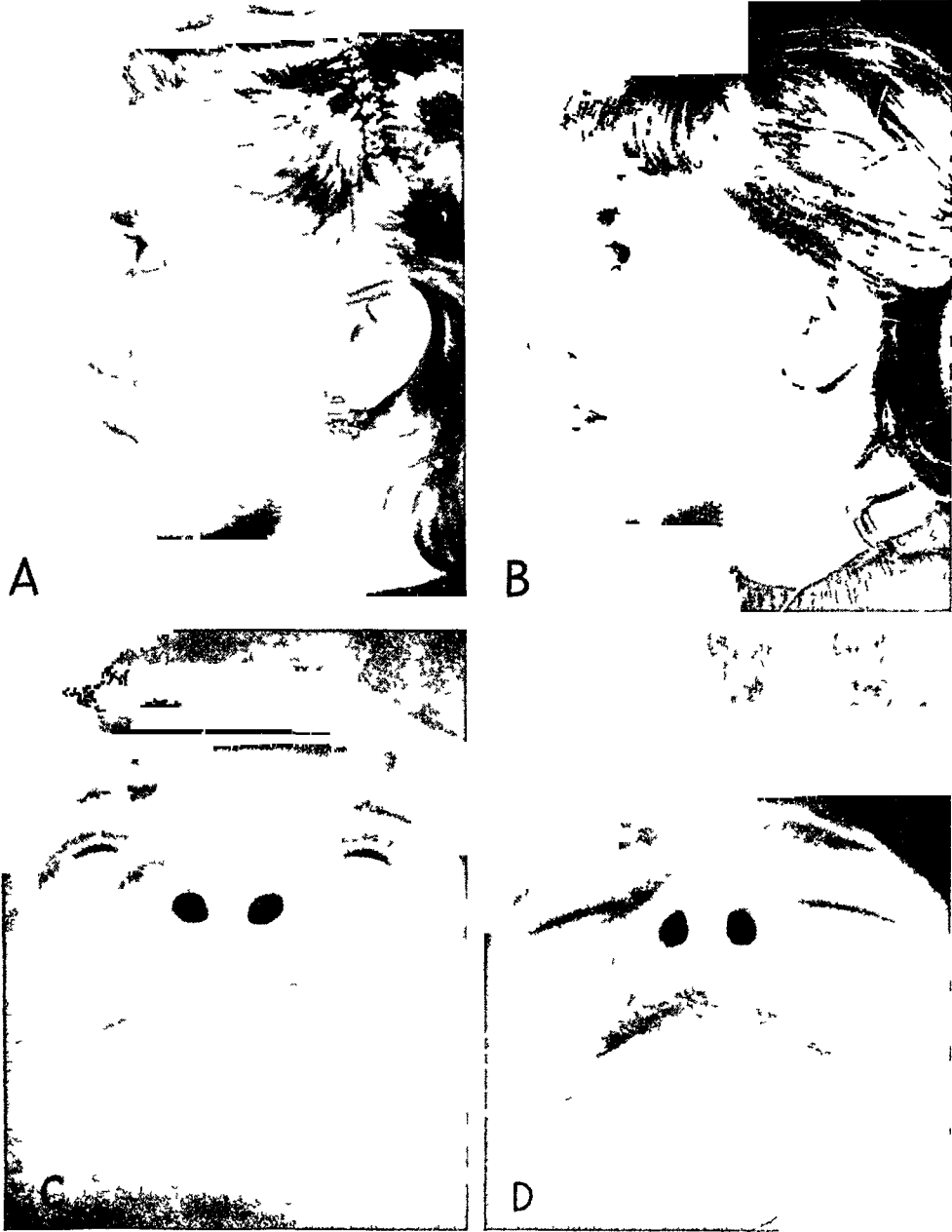


Fig 7—*A*, patient with a slight hump of the bony vault of the nose, a saddle of the upper cartilaginous vault, a deformity of the nasal tip and an acute nasolabial angle. *B*, the same patient after reconstruction of the nose. Note the change in the direction of the upper lip as compared with *A*. *C*, the base of the nose before correction. Wide flaring nostrils diagonally directed nares, short columella and large lobule. *D*, the base of the reconstructed nose. Nostrils taken in, columella lengthened and direction of the nares vertical.

was transplanted through the transfixion incision and placed in front of the anterior nasal spine in order to correct the acute nasolabial angle

C and *D* demonstrate the change of the base of the nose. *C* shows the condition before the operation: wide flaring nostrils, a short columella and a large lobule. Each naris extends in a diagonal direction. *D* shows the same patient after the operation. One can see the lengthened columella, the small lobule, the taken-in nostrils and the vertical direction of the nares.

In conclusion a principal statement may be permitted, concerning the reconstruction of the columella and the lower cartilaginous vault. Just as an architect would build a house from bottom to top, starting with the groundwork, so the same sequence should be followed for the reconstruction of the base of the nose. After the transfixion I usually follow the "bottom to top" method which Fomon⁸ introduced. First the nasolabial angle and the base of the columella are reconstructed and fixed by sutures. Then successively the operative procedures on the mesial and lateral lower cartilages are performed from bottom to top until finally the nares are taken in, and frequently a button of cartilage is placed in the tip of the nose.

SUMMARY

The suspension of the upper lip is arranged by a complex system of criss-crossing fibers similar to the so-called extension bracket used to bring forward electric equipment from a wall.

This extension bracket-like device makes possible the continuously changing position of the upper lip during eating, speaking and facial expression.

The columella, the nasolabial angle and the upper lip can be mobilized and separated by an intranasal technic. This technic consists of the use of bent scissors directed around the crescent circumference of the septal cartilage toward the nasal spine. This method does not seem to disturb the shifting mechanism of the upper lip.

Miss Estelle Brodman, College of Physicians and Surgeons, New York, helped to prepare the bibliography. Dr. Samuel Fomon gave valuable advice.

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⁸ Fomon, L. Personal communication to the author.

FUNCTIONAL AND ANATOMIC RELATION OF SPHENOPALATINE GANGLION TO THE AUTONOMIC NERVOUS SYSTEM

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SAN DIEGO, CALIF

THE SPHENOPALATINE ganglion has been associated with the sensory nervous system since it was first described by Meckel in a monograph entitled, "The Fifth Pair of Nerves"¹ It achieved clinical significance one hundred and sixty years later, when Sluder published his observations under the title "The Role of the Sphenopalatine Ganglion in Nasal Headaches"² A voluminous bibliography on the clinical aspects of the sphenopalatine ganglion has perpetuated the belief that the ganglion is a somatic sensory structure concerned with perception of pain Reports based on experimental evidence, however, indicate that it is a visceral motor ganglion, which regulates secretory and vasomotor reflexes³ Both points of view may be evaluated by a study of nasal membranes after section of the fifth sensory root and cervical sympathectomy To establish a background for these observations, a brief review of the autonomic nervous system will be given

ANATOMIC RELATIONS

The experiments of Gaskell⁴ demonstrated that visceral motor ganglions are concentrated in the cranial, thoracolumbar and sacral areas

Read before the Section on Laryngology, Rhinology and Otology at the Ninety-Seventh Annual Session of the American Medical Association, Chicago, June 25, 1948

1 Castiglioni, A A History of Medicine, translated and edited by E B Krumbhaar, New York, Alfred A Knopf, Inc, 1941, p 595

2 Sluder, G The Role of the Sphenopalatine Ganglion in Nasal Headaches, New York M J 87 898, 1908

3 Blier, X Physiology of the Sphenopalatine Ganglion, Am J Physiol 93 398, 1930 Davis, L Personal communication to the author, March 21, 1935 Dandy, W E Personal communication to the author, March 25, 1935 Kuntz, A Pathways Involved in Pains of Nasal and Paranasal Origin Referred to the Lower Cervical and Upper Thoracic Segments and the Upper Extremity, Ann Otol, Rhin & Laryng 45 394, 1936 Larsell, O, Barnes, J F, and Fenton, R A Relation of Irritation in Region of Paranasal Sinuses to Certain Vasomotor Changes, Arch Otolaryng 27 266 (March) 1938 Lewis, T, Pickering, G W, and Rothschild, P Observations upon Muscular Pain in Intermittent Claudication, Heart 15 359, 1931 Ranson, S W Personal communication to the author, April 1, 1935

4 Gaskell, W H On the Structure, Distribution and Function of the Nerves Which Innervate the Visceral and Vascular Systems, J Physiol 7 1, 1886

of the central nervous system Langley's⁵ investigations with pilocarpine, atropine and epinephrine elicited identical reactions from the cranial and sacral ganglions and opposite responses from the ganglions of the thoracolumbar group. The three anatomic groups were then considered as two functional systems. The thoracolumbar group was given the name sympathetic nervous system, the cranial and sacral groups were named the parasympathetic nervous system (fig 1). In recognition of the fact that both these systems function for the most part below the level of consciousness and independently of volitional control, they were given the name autonomic nervous system.

Typically, all reflexes are conducted across an arc of three neurons, in which the sensory and motor fibers are connected by an intermediate neuron. In the somatic system the intermediate neuron originates in the sensory area and is confined within the gray substance of the central axis. It is not regarded as either a sensory or a motor neuron. In the autonomic nervous system this neuron originates in the motor area in multipolar or motor type cells and leaves the axis by way of its motor roots. It is known as a preganglionic neuron because it terminates in one of the autonomic ganglions. By reason of these anatomic characteristics, it is regarded as having a motor function, although it serves only as an intermediary neuron. The motor function is executed by postganglionic neurons which extend from the ganglions to motor end organs in smooth muscle and glandular tissue throughout the body. Thus the autonomic nervous system is not a reflex system and does not initiate sensory impulses. It is defined as a visceral efferent system composed of two motor neurons. The autonomic system is stimulated by visceral afferent nerves. Unlike somatic afferent nerves, which terminate in the sensory areas of the central axis, the visceral afferent neurons cross over into the motor area and terminate in synapse with the preganglionic neurons of the autonomic system. They are analogous to the intermediary neurons of the somatic reflex arc. Much confusion in clinical literature results from failure to recognize this fact. A number of syndromes are described in which pain is regarded as a function of the sympathetic or parasympathetic nervous system. In otolaryngology the most familiar are sphenopalatine and vidian neuralgias.

The synapse, which is interposed between the sensory and the motor portion of a reflex arc, is more than a mere relay station. A stimulus may spread in either direction within a single fiber, but after entering a synapse it becomes irreversible and can progress only in the direction of the motor neuron. The synapse acts as a gate which opens

5 Langley, J. N., and Dickson, W. L. On the Local Paralysis of the Peripheral Ganglia, and on the Connection of Different Classes of Nerve Fibers with Them, *Proc Roy Soc, London* 46 423, 1889

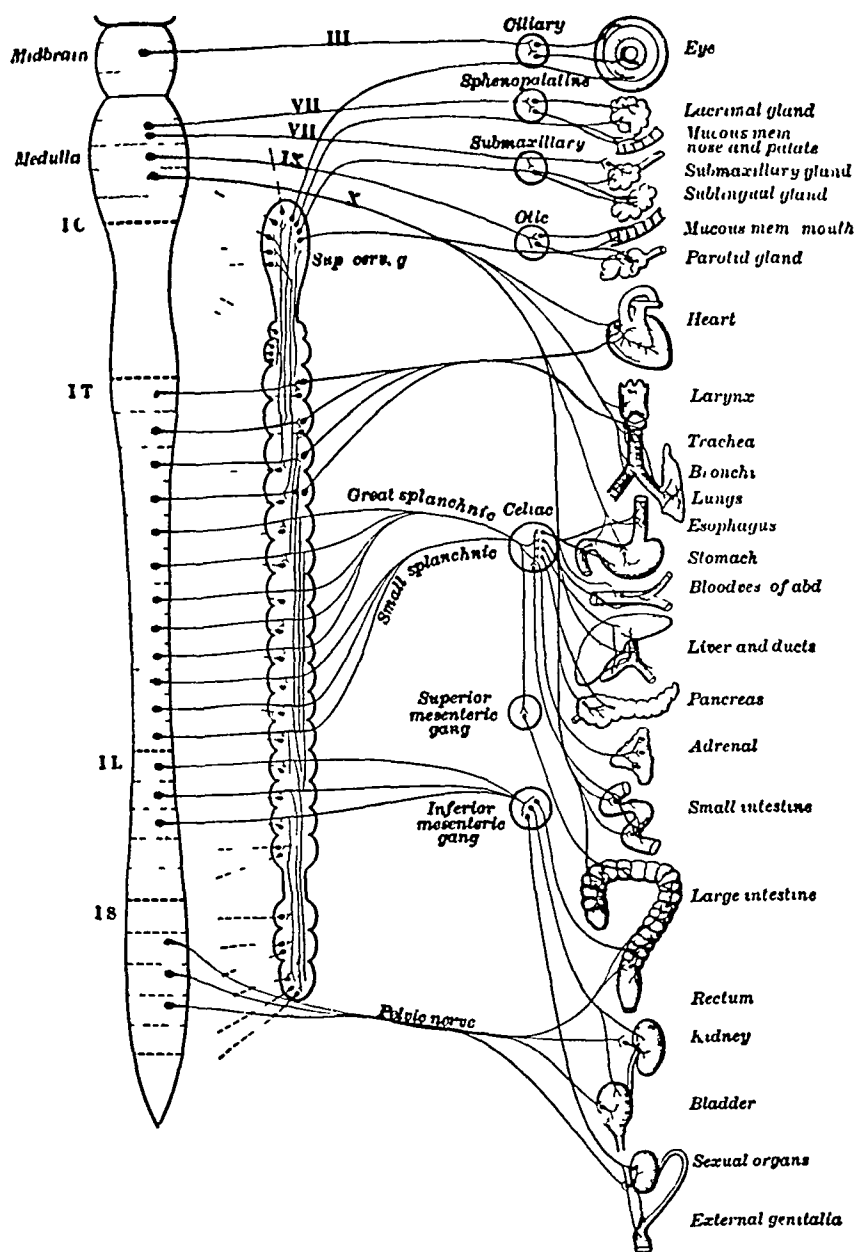


Fig 1—Diagram of spinal efferent outflow of the autonomic nervous system, modified from H H Meyer and R Gottlieb (*Die experimentelle Pharmakologie als Grundlage der Arzneibehandlung*, ed 2, Berlin, Urban and Schwarzenberg, 1911)

Preganglionic neurons of the parasympathetic nervous system leave the central axis by way of motor roots of the third, seventh, ninth and tenth cranial nerves and the second, third and fourth sacral nerve roots. They extend for relatively great distances to reach parasympathetic ganglia located close to the structures, which are innervated by short postganglionic neurons. In the sympathetic nervous system, the preganglionic neurons are short. They terminate in sympathetic ganglia relatively distant from the tissues, which are innervated by long postganglionic neurons.

only in one direction,⁶ This determines that the function of any peripheral neuron is either sensory or motor but never both

Stimulation of the sympathetic nervous system is characterized by a diffusion of impulses to all tissues which fortify the body under conditions of stress or against emergencies which arise in the external environment There is no comparable mass reaction in the parasympathetic system Its activities are concentrated on localized areas or single structures and take place without noticeable effect on other organs These responses are determined by the manner in which the preganglionic neurons of each system are distributed With few exceptions, involuntary structures throughout the body are innervated by the postganglionic neurons of both the sympathetic and the parasympathetic divisions (fig 1)

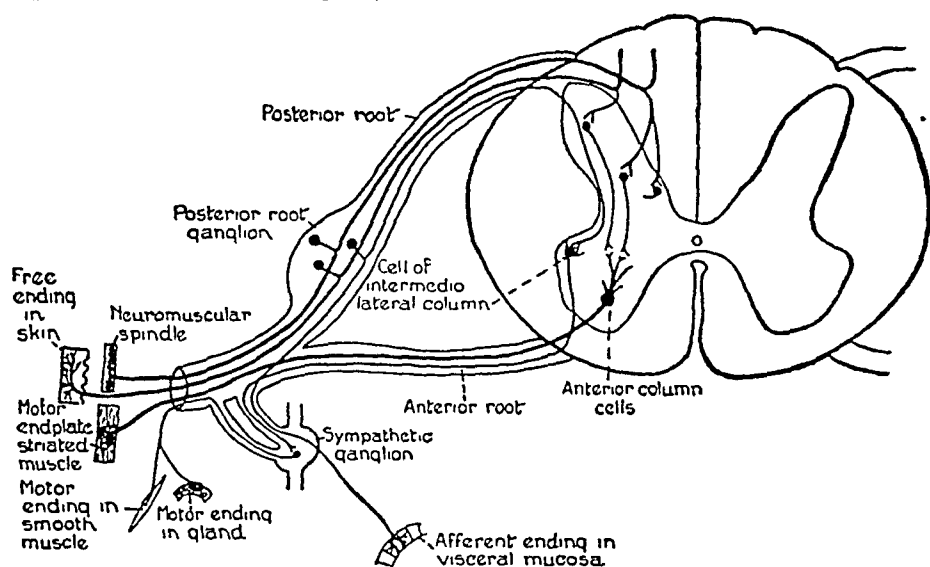


Fig 2—Diagram of spinal cord and spinal nerve roots (Larsell, O Text-book of Neuro-Anatomy and the Sense Organs, New York, D Appleton-Century Company, Inc, 1939)

The cell bodies of neurons which begin in the skin and muscle spindles are in the posterior root ganglion They terminate in the posterior columns and form synapses with intermediate neurons confined within the cord They form synapses with motor cells whose neurons terminate in striated muscle This arc forms the somatic sensorimotor reflex The cell body of the neuron which begins in the visceral mucosa terminates in the intermediolateral column in synapse with the cell body of a preganglionic neuron It leaves the cord along with somatic motor nerves and becomes part of the mixed spinal nerve It terminates in a sympathetic ganglion in synapse with cells of postganglionic neurons which innervate smooth muscle and glands The preganglionic neuron is also called the white ramus communicans because it is covered by a myelin sheath as far as the ganglion The postganglionic neuron is known as the gray ramus communicans This is the visceral sensorimotor reflex of the sympathetic nervous system

6 Best, C H, and Taylor, N B Physiological Basis of Medical Practice ed 4, Baltimore, Williams & Wilkins Company, 1945

Sympathetic Nervous System—The origin of the sympathetic nervous system is the intermediolateral column, which extends from the first thoracic to the third lumbar segment of the spinal cord. In cross section, it is found in the lateral ventral area of the gray substance, where it forms the lateral, or sympathetic, horn. Visceral sensory fibers terminate in this column in contact with the multipolar cell bodies of pre-ganglionic sympathetic neurons (fig 2)

These neurons leave the cord by its ventral roots along with the somatic motor fibers, which are distributed to skeletal muscles. They

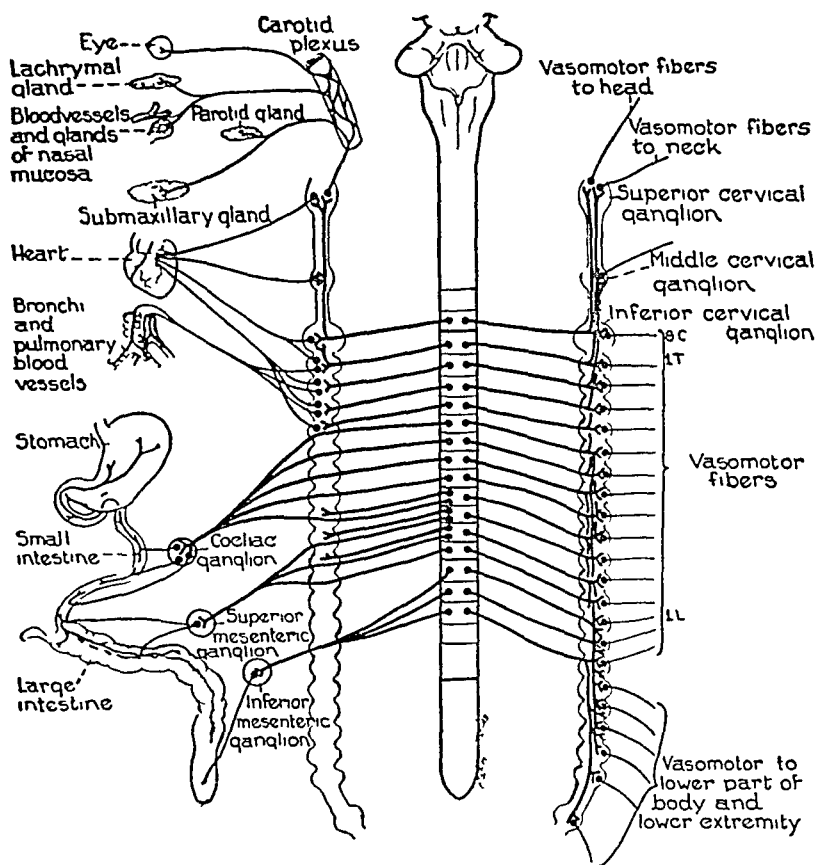


Fig 3—Schema of thoracolumbar visceral efferent connections, showing those with internal viscera on the left side and those with peripheral organs on the right side (Larsell, O. *Textbook of Neuro-Anatomy and the Sense Organs*, New York, D Appleton-Century Company, Inc., 1939)

branch off from the mixed spinal nerve just distal to the union of the ventral and the dorsal roots and terminate in sympathetic ganglions, which are located on each side of the spinal column from the base of the skull to the coccyx. Each neuron bifurcates in such a manner as to contact many ganglions both above and below its segmental level⁷

⁷ White, J. C., and Smithwick, H. *The Autonomic Nervous System*, ed 2, New York, The Macmillan Company, 1941 p 35

a touch or an image on the retina may accelerate the heartbeat and the respiratory rate, dilate the pupils, cause contraction of the hollow viscera and increase the tone of striated muscle (figs 1 and 3)

The sympathetic innervation of the head and neck begins with preganglionic neurons of the upper two thoracic segments, which terminate in the superior cervical sympathetic ganglions. Postganglionic neurons which extend into the head by forming plexuses along the walls of the great blood vessels terminate in the lacrimal glands, the dilator

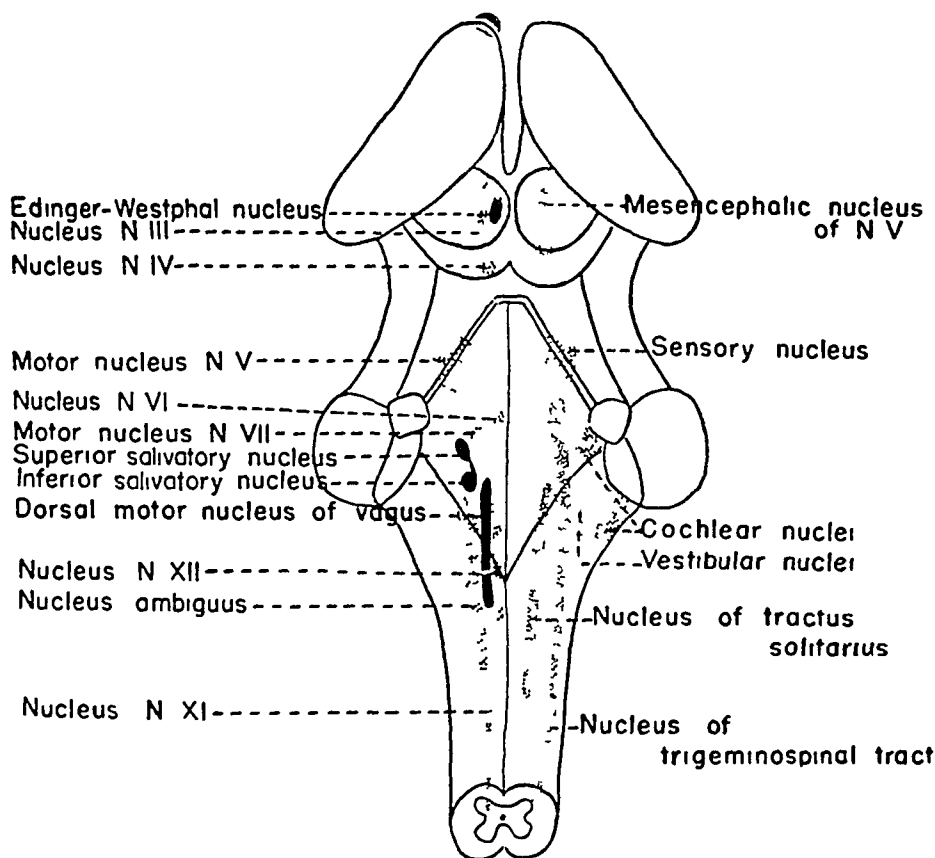


Fig 5—Dorsal view of the human brain stem with the nuclei of the cranial nerves projected on the surface (Kuntz, A. The Autonomic Nervous System, ed 2, Philadelphia, Lea and Febiger, 1934). The motor nuclei are represented on the left side, the sensory nuclei, on the right side.

muscle of the pupil, the smooth muscle of blood vessels and the mucosa of the upper respiratory and the digestive tract. Normally, they have little effect on nasal and lacrimal secretions or on the circulation of the blood. Under conditions of stress, they dilate the pupil, widen the palpebral orifice and act as vasoconstrictors (fig 4).

Distribution of the Parasympathetic Divisions—Preganglionic fibers take origin from the visceral efferent column of nuclei which extends from the midbrain through the medulla (fig 5). They emerge with

the third, seventh, ninth and tenth cranial nerves. The tracts associated with the third, seventh and ninth cranial nerves follow along these nerves to make connections with the ciliary, sphenopalatine, otic and submaxillary ganglions. The fibers associated with the tenth nerve arise in the dorsal motor nucleus of the vagus nerve and terminate in the various parasympathetic ganglions of the thorax and abdominal viscera. This nerve is characterized by long preganglionic and short postganglionic neurons, which innervate specific structures within restricted areas.

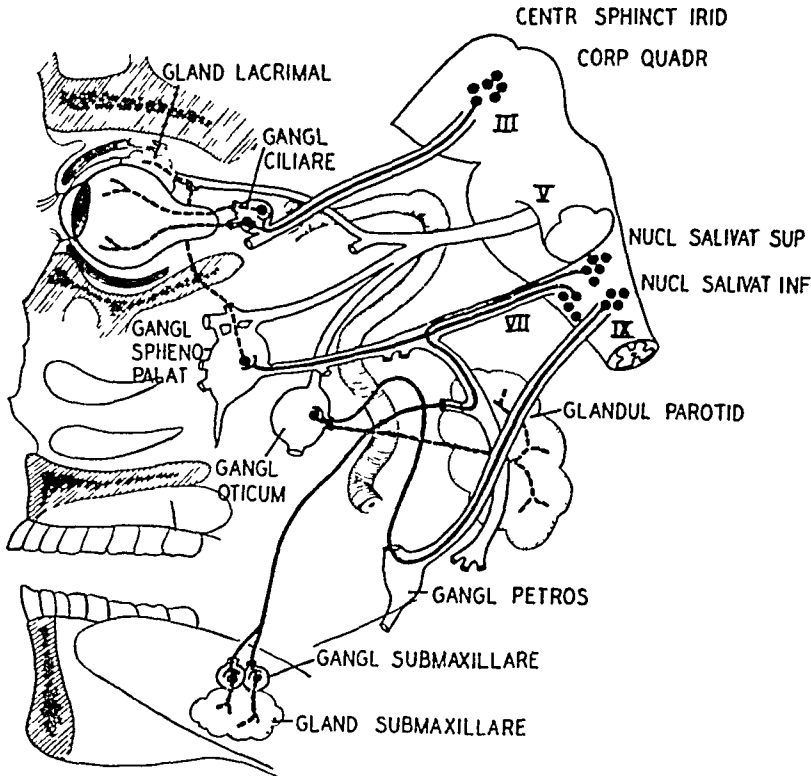


FIG 6—Distribution of parasympathetic fibers and ganglions of the head (author's modification of an original from Mueller, L R, and Dahl, W. *Die Lebensnerven*, Berlin, J Springer, 1933)

Tracts Associated with the Third Nerve The central origin for the parasympathetic innervation of the eye is the Edinger-Westphal nucleus, located deep in the midbrain. Preganglionic fibers emerge with the oculomotor nerve and enter the orbit, where a synapse is made within the ciliary ganglion. Postganglionic fibers pierce the sclera and terminate in the constrictor pupillae (fig 6).

Tracts Associated with the Seventh Nerve The superior salivary nucleus is the origin of two preganglionic fiber tracts which emerge in the nervus intermedius. One of these, the great superficial petrosal nerve, terminates in the sphenopalatine ganglion after traveling through

the petrous bone and the pterygoid canal. Postganglionic fibers are distributed to the lacrimal glands and the mucosa of the upper respiratory tract. Their function is vasodilation and stimulation of lacrimal and nasal secretions. The second of these tracts follows the seventh nerve into the facial canal, together with the chorda tympani nerve, and terminates in the submaxillary ganglion. Postganglionic fibers enter the submaxillary and sublingual glands, they stimulate salivary secretion and increase the circulation by vasodilation (fig 6).

Tracts Associated with the Ninth Nerve The inferior salivary nucleus is the origin of preganglionic fibers which are carried along in the ninth nerve and terminate in the otic ganglion by way of the tympanic branch and the small superficial petrosal nerve. Postganglionic fibers are distributed through the auriculotemporal nerve to the parotid gland. Their function is stimulation of parotid secretion and vasodilation (fig 6).

Tracts Associated with the Tenth Nerve The various glands and the smooth musculature of both the respiratory and the digestive tract, from the pharynx to the pelvis, receive parasympathetic innervation from the dorsal motor nucleus of the vagus nerve. Long preganglionic fibers are distributed to the various peripheral ganglions, where synapses are formed with short postganglionic fibers (fig 1).

Splanchnic Distribution Parasympathetic fibers to the pelvic viscera originate in the anterior horns of the second, third and fourth sacral segments. Preganglionic neurons leave the cord by the anterior roots and converge to form the pelvic nerves. They terminate in the hypogastric plexuses, which contain the cell bodies of postganglionic neurons (fig 1).

FUNCTIONAL RELATIONS

This brief review presents anatomic evidence for the functional independence which exists between the sympathetic and the parasympathetic nervous system. The sphenopalatine ganglion is usually described as a structure composed of various "roots." It is stated that fibers from the fifth nerve form a sensory root, that the great deep petrosal nerve is the sympathetic root and that the great superficial petrosal nerve forms the motor root.

In the embryo, when cell layers are differentiating into organized tissue, nerve fibers and blood vessels push toward their respective destinations by routes which do not always follow general patterns. A most striking example is the presence of the internal carotid artery and abducens nerve within the cavernous sinus. This variation has no influence on the character or specific functions of the structures involved. Similarly, when fibers of the fifth nerve and the great deep petrosal nerve encounter the body of the sphenopalatine ganglion blocking their

paths, some pass through it and others pass around it. Within the body of the ganglion, then, are somatic sensory (fifth nerve) fibers, sympathetic (great deep petrosal) fibers and parasympathetic (great superficial petrosal) fibers. Serial sections of the ganglion, however, show that the fibers of the superficial petrosal nerve terminate in the ganglion and form a synapse with its cell bodies. The fibers of the fifth cranial nerve and the deep petrosal nerve pass through the ganglion without interruption. Since functional relation is established only by synapses, these neurons do not have the significance which the terms "sensory root" and "sympathetic root" imply. Physiologically, they may be regarded as extraneous fibers.

Sphenopalatine Neuralgia—The sphenopalatine ganglion is found within the pterygopalatine fossa behind the upper posterior wall of the maxillary sinus. It appears on dissection as a flat expansion of nerve tissue about 5 to 7 mm. in length, at the anterior end of the vidian canal.

Several important structures converge within this fossa and pass through the sphenopalatine foramen for distribution to the mucosa of the nose, sinuses, palate and pharynx. They are the sphenopalatine artery, the maxillary division of the fifth nerve, which supplies sensory fibers, and postganglionic fibers from the superior cervical sympathetic and sphenopalatine ganglions, which supply vasomotor and secretory fibers.

The clinical literature indicates some confusion as to the location, size and function of the ganglion. Those who accept sphenopalatine neuralgia as a clinical entity advocate two therapeutic procedures, which are inherently contradictory. One is cocaineization by intranasal application, the other is injection of phenol and alcohol by puncture of the lateral nasal wall, or through the posterior palatine canal. No one has questioned why it is necessary to puncture the lateral wall of the nose or use the posterior palatine canal if the ganglion can be reached by a nasal applicator. It is apparent that since the ganglion lies in the pterygopalatine fossa it has never been cocaineized.

The action of cocaine is twofold. It paralyzes sensory nerves and stimulates the response of tissues innervated by the sympathetic nervous system.⁸ Application of cocaine to the nasal membranes induces the following reactions: 1. Anesthesia, which follows paralysis of the maxillary nerve. 2. Constriction of blood vessels and increased secretion of mucus, which result from stimulation of the sympathetic nervous system. The expression "cocaineization of the ganglion" means nothing more than an application of cocaine to the region of the sphenopalatine foramen. Injection into the ganglion is a blind procedure directed

⁸ Cannon, W. B., and Rosenblueth, A. *Autonomic Neuro-Effector Systems*, New York, The Macmillan Company, 1937, p. 143.

toward a small and loosely suspended structure. It is accomplished as much by chance as by skill, regardless of whether the Sluder or the Ruskin needle is used. The subsequent pain gives evidence that the maxillary nerve has been injured by an injection which has entered the fossa but missed the ganglion. If the injury is sufficient to cause degeneration of the nerve, the nasal mucosa will be paralyzed for the period of regeneration. It is a dangerous and ill advised procedure.

*Vidian Neuralgia*⁹—Another syndrome which associates pain with the function of the autonomic nervous system is known as vidian neuralgia. The vidian nerve is described anatomically as an anastomosis of the great superficial petrosal nerve and the great deep petrosal nerve

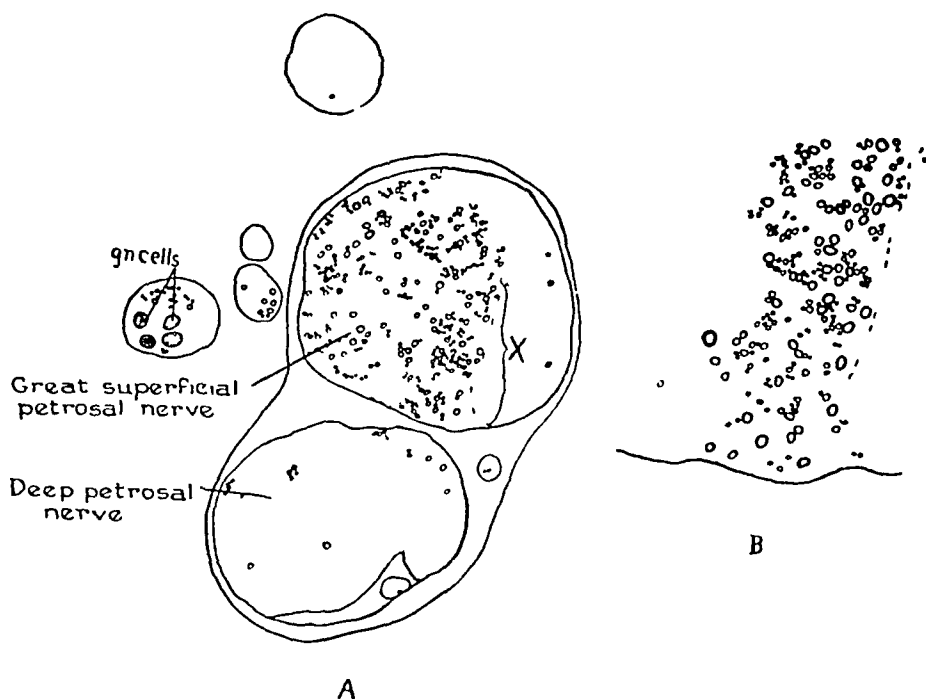


Fig 7—Section of human vidian nerve, osmic acid preparation (Larsell, O Textbook of Neuro-Anatomy and the Sense Organs, New York, D Appleton-Century Company, Inc, 1939) A, section showing areas of myelinated fibers, indicated by rings of various size, and unmyelinated fibers, indicated by clear areas, B, the region indicated by X in A, more highly magnified

in the vidian canal. The great deep petrosal nerve, however, is a bundle of postganglionic neurons which extend from the superior cervical sympathetic ganglion to the nasal mucosa and lacrimal gland without interruption. The great superficial petrosal nerve is composed of pre-ganglionic fibers extending from the superior salivary nucleus to the sphenopalatine ganglion. An anastomosis of these fibers would violate

⁹ Vail, H H. Syndrome of Pain in Its Reference to the Eye, Ear, Nose and Throat, Tr Am Acad Ophth 38 255, 1933

the distinctive pattern of distribution, which is elsewhere rigidly observed. Larsell¹⁰ has studied the vidian canal in cross section and demonstrated that the two nerves are completely separated by a sheath of connective tissue. Instead of a vidian nerve, there are two nerves which occupy the vidian canal (fig 7).

Occasionally, the nerves are directly exposed in the floor of the sphenoid sinus by a congenital failure of the canal to close. Under these conditions, relief from pain by an application of cocaine is presumptive evidence of vidian neuralgia. It would be difficult to apply cocaine to the canal without making contact with the mucosa of the floor of the sphenoid sinus. Furthermore, both nerves are part of the visceral motor system, which does not conduct sensory impulses. It is more plausible to explain the cessation of pain by the effect of cocaine on the fibers of the fifth nerve which are distributed within the sinus.

CLINICAL OBSERVATIONS

Observations were made on 16 patients after section of the fifth sensory root.

- 1 The color, thickness and secretory activity of the mucosa gave no evidence which indicated whether the right or left nerve had been severed.

- 2 Reactions which result from absorption through the blood stream or from endosmosis were normal. Atropine administered by mouth paralyzed the secretory glands, and applications of cocaine and ephedrine induced vasoconstriction.

- 3 There was complete anesthesia, which abolished intranasal reflexes.

A study was made of 11 cases of paralysis of the sympathetic nervous system. Two occurred after cervical sympathectomy, and 9 were cases of Horner's syndrome. The following observations were made:

- 1 Vasoconstrictors were more effective on the membranes of the control side in 7 patients.

- 2 No difference was apparent between the affected and the control side in 4 patients.

- 3 There was no pain or impairment of the sense of touch in any of these patients.

The function of the sphenopalatine ganglions was studied after the administration of atropine, which paralyzes the parasympathetic nervous system. The following observations were made:

- 1 The secretory glands, smooth muscle and ciliary activity were inhibited.

¹⁰ Larsell, O. L. *Anatomy of the Nervous System*, New York, D. Appleton-Century Company, Inc., 1942, p. 124.

2 The reflexes which maintain the normal color, thickness, moisture and hygiene of the nasal membranes were paralyzed

SUMMARY

The anatomy of the autonomic nervous system is briefly reviewed in order to establish a logical background for statements in this paper which are contrary to prevailing opinion

The sphenopalatine ganglion has been of clinical interest for many years, chiefly because of its association with pain. It is wholly associated with the parasympathetic nervous system and relays vasodilator and secretory impulses from the superior salivary nucleus to the lacrimal gland and to the mucosa of the upper respiratory tract, it has no functional relation to the fifth nerve.

Nasal membranes, like all other organs of the body, are influenced by the activities of the autonomic nervous system.

Observations following paralysis of the sympathetic nervous system, section of the fifth sensory root and administration of atropine suggest the following conclusions:

1 In the nasal mucosa, sensory impulses are conducted by the fifth cranial nerves.

2 Vasoconstriction is the dominant effect of stimulation of the sympathetic nerve fibers. Normally, this reflex is inactive because of its high threshold for stimulation.

3 The parasympathetic nervous system has a low threshold for stimulation. Vasodilator and secretory fibers from the sphenopalatine ganglions are continuously making adjustments to atmospheric conditions and constitutional states in an effort to maintain a normal nasal membrane. This is the function of the sphenopalatine ganglion.

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ABSTRACT OF DISCUSSION

DR. W. E. GROVE, Milwaukee. Since the time of Sluder, controversy has raged concerning the function of the sphenopalatine ganglion, and, so far as the autonomic nervous system is concerned, it has, for most otolaryngologists, been *terra incognita*. I know of no one who has done more to clarify and simplify the function of the autonomic nervous system than has Dr. Higbee.

The explanation of the craniosacral segment as belonging to the parasympathetic nervous system and the thoracolumbar segment as belonging to the sympathetic nervous system makes it understandable. The mass action of the sympathetic nervous system, as compared with the more localized responses of the parasympathetic nervous system, is a point which deserves consideration. The anatomic description which points out the functional independence of the somatic, the sympathetic and the parasympathetic nervous system is admirable.

Dr Higbee's arguments against the position that the vidian nerve and the sphenopalatine ganglion are the focal points in the production of the atypical facial pains in the so-called vidian neuralgia and the sphenopalatine ganglion syndrome are well taken on purely anatomic grounds

DR W LIKELY SIMPSON, Memphis, Tenn Dr Higbee brings out the point that the sphenopalatine ganglion should cease to be associated with the sensory nervous system and be considered in its true anatomic and functional position as a member of the parasympathetic (craniosacral) nervous system

He also demonstrates that the vidian nerve is, in reality, two nerves, both of which are members of the autonomic nervous system On the basis of these two facts, he contends that the terms sphenopalatine neuralgia and vidian neuralgia should be discarded, since they both are in fact trigeminal neuralgias

I am glad to hear that Dr Higbee feels strongly against the injection of alcohol in the region of the sphenopalatine ganglion I have never been in sympathy with this procedure Pain is a symptom calling for thorough investigation the elimination of the possibility of poor teeth, infection, a pathologic nasal condition or tumors of the nasopharynx before anything other than simple procedures are instituted

I heartily agree with the author's conclusions that the sensory innervation of the nasal mucosa is from the fifth cranial nerve and that vasoconstriction is the dominant effect of stimulation of the sympathetic nerve fibers, whereas vasodilation and secretory regulation are the role of the parasympathetic nervous system

Dr Higbee's paper has given us an excellent review of the basic anatomy, and function of the autonomic nervous system, with the practical application of this knowledge

POSTGRADUATE TRAINING IN OTOLARYNGOLOGY

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IN THE report of the Commission on Graduate Medical Education,¹ published in 1940, the phases of training which followed the customary four year medical course were divided into three categories

The first is the internship, which rounds out and gives added practical application to the medical school course and also accustoms the individual, while under supervision, to the assumption of responsibility. Hence, it should be considered a part of the basic preparation for practice. The second part is the residency, which prepares a physician for the practice of a specialty and, therefore, is properly termed graduate medical education. Finally, there are courses of varying lengths and other educational opportunities that aim to keep practitioners abreast of their present fields of practice and they can be correctly classed as postgraduate education.

While we approve this classification, and hope that eventually it will be accepted by all institutions of medical education, we shall not conform to it in this discussion, because it would be confusing if our terminology were at variance with that of our school. At the University of Illinois it has been the practice to restrict graduate education to the basic sciences and to group all advanced clinical training under the term postgraduate medical education. As a part of the University of Illinois, we shall discuss training in otolaryngology as a postgraduate educational entity.

Postgraduate training, in otolaryngology as in the other specialties, encompasses a wide field of instruction, the goals of which can be reached only by a long range program in a school intent on fulfilling the needs of modern medicine. The past two to three decades have so broadened the scope of medicine that specialization has of necessity become essential in order to provide the type of care to which the general population is entitled. Several departments of otolaryngology in this country have endeavored to meet the problem of postgraduate

From the Department of Otolaryngology, University of Illinois College of Medicine

1 Graduate Medical Education in the United States. I Continuation Study for Practicing Physicians, 1937-1940, Council on Medical Education and Hospitals of the American Medical Association, Chicago, American Medical Association, 1940

education, despite the fact that the medical schools of which they form a part have been slow in recognizing and in adapting themselves to the new educational demands

Perhaps the greatest problem encountered in postgraduate education in the specialties concerns the place it occupies in the total framework of medical instruction. The medical school has been developed for the purpose of training undergraduates for the practice of medicine and surgery, and usually it either ignores the postgraduate program or allows it to continue as a departmental hobby, which at best gives it only a quasirecognition bearing the bar sinister. Frequently, the department is reminded that its function is undergraduate teaching and that such "extracurricular" activities, while permitted, must remain a secondary function. To a large extent, this situation is due, not to a lack of sensibility to the necessity for such a training program, but to the responsibility which formal recognition implies. A formal course requires budgetary commitments, space allocation, material and personnel provision of considerable proportions. Multiply these factors by the number of specialty departments and one can readily understand the hesitancy with which the school will enter the new academic field. It is difficult to foresee the time when all schools will offer a comprehensive postgraduate program in each specialty, and we cannot be sure that the needs justify this end. A few schools will undoubtedly achieve this state, but most will satisfy themselves and the demand by offering a limited number of postgraduate courses in a few specialty departments. When the medical schools realize that they are not faced by an all-or-none situation, and when each school learns to consider itself as but one unit in the larger picture of national medical education, postgraduate training, in otolaryngology and in the other specialties, will lose the academic stigma which now accrues to it and will assume its legitimate place in the framework of the graduate college.

What is the place of postgraduate specialty training in the graduate school, or, rather, what is the responsibility of the graduate school in the educational structure? It must bridge the gap between the degree of Doctor of Medicine and certification by the specialty board of examiners. It must provide a curriculum and facilities in line with a national standard so that completion of the course will merit automatic award of specialty board certification. For acceptable fulfillment of the requirements of the course, the graduate school should, perhaps, provide a suitable degree. Some institutions at present confer the degree of Master of Arts or Master of Science, but this is inappropriate, and a step down from the degree of Doctor of Medicine. Dr. Harry S. Gradle suggested the degree of Doctor of Science in the specialty. Through cooperation of the American Association of Medical School

Deans and the Advisory Board for Medical Specialties of the American Medical Association, the entire picture of postgraduate training in the specialties should lose its chaotic state and assume a national pattern and standard

A survey of the various specialty training courses given in this country emphasizes the need for standardization. The "acceptable" courses bear little similarity to each other. Some are purely clinical, the student performing undirected dissections on the cadaver, working in the outpatient clinic, assisting in the operating room and being "indentured" to a preceptor in a neighboring hospital, who bears the honorary title "professor" in the graduate school. From this extreme there is a gradation to the opposite one, where the student receives a didactic training and little or no clinical experience, except as an observer. The subject matter covered in these courses varies as much as the manner of teaching. In some of the specialties the requirements and methods have crystallized to the point where courses of instruction independently organized have achieved a recognizable similarity and an acceptable standard.

Postgraduate education in otolaryngology, after a long period of unorganized and undirected effort, is coming of age in the development of planned and organized courses in the various educational institutions of this country. From a historical standpoint, postgraduate training in otolaryngology had its beginnings and development on the continent of Europe, especially in Vienna, where so many gloried in the wealth of clinical and cadaver material and in the excellent instruction available there. However, despite the superlative advantages of training in Vienna, there were glaring inadequacies in the method. The student presenting himself for training found no plan to follow, no course outline, no time structure in which he could complete an adequate training program. He had to choose various courses from individual men and had to rely on those who preceded him for some idea as to what courses he wanted and what men he should select for instruction. It was not unusual, for example, for a new postgraduate student to begin his work with intracranial complications and discover his need for knowledge of the acute and chronic diseases and finally end with a course in anatomy. There is no doubt that some knowledge stuck, and all of it was valuable, but a structure so haphazardly built could not, in most instances, enlarge and produce a logical and scientific understanding of the specialty. To a background of this type must be laid the responsibility for the constant narrowing of the specialty and the loss through default of much that it should include.

In the United States, postgraduate training in otolaryngology remained largely on a preceptor basis, though special internships or

residencies had been established in a few places. The most outstanding of these included the Massachusetts Eye and Ear Infirmary, the New York Eye and Ear Infirmary, the Manhattan Eye and Ear Infirmary, the Philadelphia Polyclinic and Graduate Hospital, the Illinois Eye and Ear Infirmary, and the New Orleans Touro Infirmary. At some of these institutions the "chiefs" improved their technical skill and made clinical observations which added to the background of the specialty, but the residents had little opportunity to act as more than assistants. The emphasis was on clinical medicine, particularly on surgical procedures. Physiology was only of academic interest. The value of pathology was becoming more evident, but it did not assume an important place in the teaching program. There was little or no planned teaching. The student read what he would, absorbed what he observed and heard and practiced what he could. The system produced clinicians with little learning and restricted skill.

In the mature minds of the specialists in this country, the need for a more formalized pattern of training was growing more and more evident, and the beginnings of educational plans to meet it were variously conceived in a few institutions. The establishment of the American Board of Otolaryngology as the recognized criterion of the status of specialist, and its demand for an ever increasing high standard of knowledge have given impetus to the postgraduate training program. More institutions provided training, and the course content was enlarged to include not only clinical otolaryngology but also a little of the basic scientific background.

An evaluation of such a program by the American Board of Otolaryngology, by the various specialty societies and by the teaching departments of otolaryngology led to the conclusion that improvement in postgraduate education had been achieved but that it was still sub-standard. It was impossible to produce a better specialist by a postgraduate education so largely concerned with clinical medicine and so inadequately concerned with the basic sciences necessary to support a superstructure becoming daily more intricate and varied. The specialty boards have set the length of the residency at three years, one of which is to be restricted to the study of the basic sciences.

Unfortunately, the mere knowledge that a basic course was essential to specialistic training was not sufficient to produce such a course. A new type of formal teaching is not established without encountering numerous problems, which must be variously solved or about which compromises must be made. The pioneer courses evidenced a relatively slow evolution. Those who would begin to offer postgraduate training today may profit from the trial and error results of men who first undertook to set it up.

For example, postgraduate training in otolaryngology at the University of Illinois dates back to the founding of the department. At its inception the training was purely clinical and very informal. The transition was slow. The first formalism in teaching came with the appointment of a resident at the Research and Educational Hospitals, in 1925. The emphasis was still clinical. Nonclinical study was elective and relegated to spare time and evenings. By 1926, it was felt that postgraduate training prior to residency was desirable, but it was not until 1927 that it became mandatory. When the decision was made to require basic training as a prerequisite to residency training, the responsibility for providing such training was recognized and accepted by the department of otolaryngology. Short courses were organized and offered in 1927. The following decade was one of growth and expansion. In 1937, the first basic course was given requiring a full academic year. World War II interrupted the continuity of these courses for a time, but in 1946 the program was resumed. No course has been a duplicate of the one preceding it, nor do we expect to reach a day when, on critically assaying a completed course, we shall feel that it could not be improved.

An analysis of the postgraduate training program revealed several aspects which required attention as separate and distinct entities. The induction of the neophyte into the specialty was the most difficult task, and we found that it could best be treated in two parts—the basic course and the residency. The maintenance of a high standard in the specialty could best be supported by refresher and instructional courses, in addition to the research courses leading to the master's degree. The integration of such a postgraduate program in the department of otolaryngology at the University of Illinois has been a twenty year development.

THE ORGANIZATION

A formal course of education requires a complex machinery that functions in relation not only to the student but also to the school and to outside persons and institutions. It involves planning, voluminous correspondence, material and personnel. The larger part of the work is completed when students appear for the first class period. The structure necessary for a postgraduate course program requires the following divisions of a department: administrative, planning and instructional. An experienced laboratory technician, who also serves as a photographer to prepare visual aids, is most essential to a comprehensive postgraduate training program.

The administrative division at the University of Illinois is composed of the head of the department, an executive secretary, who is a member of the teaching faculty, and a clerk-stenographer. The head of

the department must assume those responsibilities which the University does not permit him to delegate to others. In addition to this, he can usually secure more effective cooperation from other departments by informal requests to their heads. These are always followed by a formal request from the executive secretary, and the method has proved most satisfactory. It is incumbent on the head of the department to set the standard of teaching and to instil into the members of his department a desire for enthusiastic participation in the project.

The duties of the executive secretary are largely to translate the broad proposals of the planning group or postgraduate course committee into an hour by hour schedule of teaching. He must keep needless repetition at a minimum and be sure that the entire program is carried to completion. Once the program is in operation, only he should be authorized to make changes in it, otherwise difficulties are certain to arise. For example, if the head of the department invites the class to meet him at a certain hour, he may be taking the class away from a lecture by the sensitive head of another department, who may resent appearing before an empty classroom and may be unwilling to cooperate in the future.

The planning group or postgraduate course committee is composed of the head of the department, the executive secretary and several members of the teaching staff. It determines the qualifications of applicants for admission to the course. It is the hope of the committee that those selected will, by the completion of the course, meet the standards set forth in the class code.

CLASS CODE

Each member should be a progressive student of otolaryngology. To this end, he should be a thoughtful reader of scientific literature, should attend and participate in professional society meetings, should engage in such experimentation and collection of data as will test the value of scientific theories and aid in the establishment of a sound basis for otolaryngologic practice and should be willing to give his fellow practitioners the benefit of his professional knowledge, skill and experience.

The postgraduate course committee formulates the objectives. Before we train an otolaryngologist, we must first determine the scope of that narrow and restricting specialty label. It is our desire and plan eventually to change our designation from the department of otolaryngology to the department of head and neck surgery. We include all diseases and surgery of the head and neck, with intracranial and orbital exceptions, as being within the scope of our specialty. The training objectives are equally broad. We have not given way, and shall not, to each new encroachment on the confines of our specialty, indeed, we expand by including the new pertinent fields as they develop.

The committee decides on the course content, with respect not only to the subjects to be covered, but also to the time to be provided for them. It also determines changes in teaching personnel and suggests guest lecturers for special subjects. In addition, the group must critically examine each preceding course, discuss its shortcomings and recommend changes in content and presentation. In the critique of a course several factors must be taken into account. Student reaction to course content is often unreliable and should not prove the only determining factor in altering the structure of a program. The student usually lacks the over-all picture, he tends to focus on each individual pebble, not realizing that it is only a part of the whole mosaic. His reaction to the manner of presentation is most important. The greatest desire to learn will not overcome the soporific effect of poor preparation and delivery. Neither erudition nor clinical judgment makes a teacher. A few have an innate stage presence, most must learn the art of teaching. It is not merely a matter of words, nor even of their enunciation and emphasis. The teacher must remake himself into a dynamic personality that will hold the attention of his audience when an apparently dry subject matter tends to distract. After consideration of each subject and instructor, the recommendations of the committee are noted on the course analysis sheet (form A).

The instructional division carries out the teaching program. As we have already pointed out, this implies more than a recitation of the necessary facts. Teaching may be compared to a well prepared meal. It is not sufficient to have the proper ingredients alone, the food must be sufficiently spiced and palatably presented. Interest is the essence of good teaching. The instructor must be interested in his subject in order to interest others, and must not take it for granted that all others become interested spontaneously. The student should learn because he is interested, and not because the course must be taken for units of credit. It must be the inherent desire of the teacher to convey knowledge in the simplest manner possible. A guest lecturer at Oxford University was asked to prepare and present his material in such a manner that an 11 year old child could understand. The presentation must be human, whether it stimulates interest by the devices of humor, surprise or arousal of curiosity, it must be identified with everyday actions and reactions of life. The ability to create interest is individual. Individuality, as defined, must exist in learning, teaching, practice and investigation in the field of medicine. President Scott of Northwestern University predicted that in the future teaching skill will be more highly rewarded than achievements in research. "Teaching is the most useful type of development that can be attained by a member of the faculty."

FORM A UNIVERSITY OF ILLINOIS COLLEGE OF MEDICINE,
DEPARTMENT OF OTOLARYNGOLOGY

Postgraduate School Course Analysis

Instructor Duration Weeks

Title

Date

Subject title

Prerequisites of student

Material required by student (instruments, gown, gloves etc)

Facilities and material required from department (cadavers, animals etc)

Maximum number of class

Total hours Divide into hours per day week

Time of day and days of week instructor available

Alternate instructor

Assistance required (laboratory, photography, nurses, resident)

Associate instructors available or suggested

Briefly summarize scope of this course or submit outline for mimeographing

Do not fill in below this line

Recommendations

Date

Date

Approved

Head of Department

Executive Secretary
of Department

As president Raymond B Allen, of Washington University, pointed out, "There is no codified methodology of teaching medicine and no science of medical pedagogy" There can be teaching principles, but those principles must not be props to the weak and infirm but must act as guideposts The most trite is oft-times the most important "If

we omitted the commonplace from our practice, there would be suprisingly little left" (Gersuny) Teaching in the medical field is different from ordinary teaching because of the subjective and variable factors which set it apart from the more exact and mathematical sciences, so, being traceable to the period of preceptorships, it is still largely a bedside technic That which makes teaching valuable are those traits of the teacher which in one's memory have remained as indelible Minus such qualities as individualize him, the teacher becomes merely another instructor joining the rest in oblivion

With a vast knowledge and a myriad of details released to a class, some check must be made on the degree of absorption It is the duty of conference leaders and instructors to find out by oral and written tests exactly what each student is accomplishing It is the duty of the instructor to make each lecture hour interesting and profitable to the entire class—an impossible, but fascinating, task "To produce vital and useful criticism it is necessary to think, think, and then when tired thinking, to think more" (Bliss Perry)

OUR COMMANDMENTS

To Teach, to Practice, to Investigate

- 1 Be concrete and keep close to your subject
- 2 Illustrate wherever possible, use visual means to interest the group
- 3 Do not ridicule your student, do not find fault
- 4 Be not critical of your colleague or about those absent
- 5 Do not talk "above" your student, teach so that all will understand
- 6 Organize your material and be careful not to "ride hobbies"
- 7 Be pleasant and quick to praise
- 8 Be interested, and you will arouse interest
- 9 Stress the preventive measures in disease
- 10 Your student is a doctor—exemplify one in his presence
- 11 Cultivate self confidence, ability and effort
- 12 Be practical and scientific, research work, to be of the highest order, must be both

The instructional department requires 3 full time or, preferably, 4 three-fourth time or 6 half-time instructors whose sole duty is concerned with postgraduate training, basic and clinical (resident training) A minimum of 3 full time instructors or teaching fellows or their equivalent in part time men is necessary in the instructional division to insure the close supervision of both the preclinical and the clinical phases of postgraduate training imperative to the development of a competent otolaryngologist All clinicians should devote some time to private practice Those cloistered in institutions lack or lose appreciation of the psychic, social and economic problems that complicate the practice of medicine Without this experience the teacher is inadequate to the task of producing practitioners to serve the public

fully The 3 full time postgraduate instructors do not include the head of the department, whose administrative duties in the university and whose responsibility for undergraduate education curtail his close association with the postgraduate student, nor does it include the many part time members of the department, whose enthusiastic cooperation is the balance between the success and the failure of the program One of the 3 may assume the function of executive secretary, though this may, for two or three years, until a course pattern is established, reduce his available teaching hours The instructional staff, while composed of clinicians, must be selected from those whose special interest in the basic subjects of anatomy, physiology and pathology fit them for a course of this type

The question arises Why not have a member of the department of anatomy teach the anatomy? If a clinician-anatomist is not available, it must be carried out that way, but it is not so satisfactory Only the experienced clinician can quicken the cadaver to living import and translate the dead to functioning life In like manner, the other basic sciences should be taught wholly or in part by clinicians, so that their import may have practical bearing on and application to the clinical practice of medicine

The instructional responsibility is a large one It is carried by a large department The departmental structure is, of course governed to some extent by the administrative, graduate and undergraduate teaching requirements of the medical school, but it has also been arranged to fill the postgraduate teaching needs The head of the department devotes seven eighths of his time to the university Two full time instructors, 6 half-time instructors and 2 teaching fellows, appointed as assistants in the department, round out the salaried academic staff In addition, there are approximately 50 nonsalaried members of the department who devote variable periods of time to the University of Illinois Hospitals, the Illinois Eye and Ear Infirmary, the Central Free Dispensary and the Veterans Hospital at Hines, Ill While the maintenance of the teaching program is the responsibility of the salaried staff, much of the credit for the success of the course must be given to the cooperating nonsalaried staff members Adequate planning allows that these nonsalaried members of the department or invited guests be given a token honorarium out of postgraduate income

We have included a laboratory technician with some photographic experience as being essential to the program The preparation of material for microscopic study and the preparation of instructional visual material requires the full time of a technician Dependence on part time personnel or on assistance from other departments for visual training material slows the tempo of the instructional program

We have mentioned cooperation with other departments. Cooperation cannot be one sided, nor can it be stinted if creditable results are to be obtained. The department of otolaryngology at the University of Illinois has been most fortunate in the support it has received from other departments, and, in return, it has welcomed the opportunity to be of service to them. An example of cooperation between departments is illustrated in the relations of the departments of otolaryngology and anatomy. The department of otolaryngology assists the department of anatomy by formal lecture on the anatomy of the ear, nose and paranasal sinuses. It presents demonstrations of the anatomy of the temporal bone, nose and paranasal sinuses. It also provides additional prosectors during the period when the class in anatomy dissects the head, neck and thorax. These lectures and demonstrations have been incorporated as an integral part of the course in freshman anatomy. The department of anatomy assists the department of otolaryngology in procuring cadaver material. It offers a regular series of lectures on the embryology of the head and neck and provides laboratory space to meet our instructional commitments. This exchange of services has been most cordial and has promoted greater personal and departmental fellowship. We acknowledge the invaluable assistance given by the departments of allergy, bacteriology, dermatology, medical illustration, medicine, neurosurgery, ophthalmology, pathology, physiology, psychiatry and roentgenology. We have not been able to make return in kind to all departments, but our facilities and personnel are available to all who call on them. This cooperation makes a family of an institution and, most important, produces a better physician, with broader knowledge and deeper understanding of the patient he is to serve.

THE BASIC TRAINING PROGRAM

We present the schedule of a basic course in otolaryngology (form B), with neither apology nor pride. It contains certain weaknesses. It may unduly stress particular subjects and inadequately cover others. We have evidence that it is a good course, but we know that it can and will be improved on. It is an evolutionary phase in postgraduate training, a compromise between an envisioned ideal and the various restrictions and limitations encountered in practical operation. We offer it for dual reasons. It is our hope that the development of more similar courses will relieve the overcrowding that has burdened us. More important, we hope to find from the experience of others solutions to the many problems that restrain our own progress toward perfection in plan and presentation. The course content is broken down into a master plan schedule, from which weekly schedules are prepared two to three weeks in advance, giving the students the time, the place and

**FORM B UNIVERSITY OF ILLINOIS COLLEGE OF MEDICINE
DEPARTMENT OF LARYNGOLOGY, OTOTOLOGY
AND RHINOLOGY**

Course Content Basic Postgraduate Program

ANATOMY OF THE HEAD, NECK AND THORAX	HOURS
(a) Dissection	240
Adequate material for dissection and study is furnished, including adult, newborn and prenatal cadavers	
(b) Gross and Microscopic Anatomy	80
Fresh and prepared specimens are employed for demonstration and study. The value of this material is enhanced by the use of photographic projections	
(c) Surgical Anatomy	40
The anatomic approach to surgery of the head and neck, including the tracheobronchial tree, is adequately covered	
EMBRYOLOGY	24
This section covers the morphogenesis of the head and neck region as a whole, the nose, primitive pharynx and its derivatives, the external, middle and internal ear, and the larynx, trachea and lungs	
HISTOLOGY AND PATHOLOGY	180
Four hours each week are devoted to lecture demonstration and group discussion of fresh and prepared histologic and pathologic material projected on the screen. Two hours each week are given to the examination of slides under the microscope by the students, individually and in groups	
PHYSIOLOGY	30
The physiology of the ear, nose and throat and the tracheobronchial tree are considered in detail, together with the practical clinical application of physiologic principles	
BACTERIOLOGY	72
A basic and practical study, with particular reference to otolaryngology	
PHARMACOLOGY	72
Particular stress is given to local anesthetics, germicides, chemotherapeutic agents, vasoconstrictors, antiallergics, water balance and postoperative fluid therapy	
ANESTHESIA	10
The material covers local and general anesthetics, and their choice, problems, complications and premedication	
ALLERGY	20
The material is concerned with the mechanism of anaphylaxis, diagnosis and treatment of protein sensitivity disease	
NEUROSURGERY	10
Particular emphasis is given to the difference in approach and technique of the otologist and the neurosurgeon	
DERMATOLOGY	10
The material includes lesions of the epidermis and mucous membrane encountered about the head and neck, and syphilis, their diagnosis and treatment	

PLASTIC AND MAXILLOFACIAL SURGERY	30
The history and types of general plastic procedures and those of interest to the otolaryngologist are included.	
BRONCHESOPHAGOLOGY	100
This study includes the anatomy of the laryngotracheobronchial tree and esophagus and their diseases. In addition, emphasis is given to the medical aspects of pathology of the chest. Endoscopic technics and practice on the cadaver and laboratory animals are carried out.	
DIDACTIC OTORHINOLARYNGOLOGY	160
The synonyms, etiology, pathogenesis, pathology, differential diagnosis, course, prognosis, complications and treatment of diseases of the ear, nose and throat are considered.	
SURGICAL PROCEDURES	30
This includes didactic description and demonstration of surgical procedures in otorhinolaryngology.	
CLINICAL SEMINARS	100
Presentation of patients from a diagnostic, therapeutic, educational or research standpoint.	
LABORATORY TECHNIQS	8
This course is designed primarily to indicate valuable technics and problems associated with the preparation of pathologic material for examination, demonstration and publication.	
PEDIATRIC ASPECTS	6
Emphasis is given to special problems encountered in juvenile patients with otolaryngologic diseases.	
STOMATOLOGY	10
A comprehensive survey of the development, function and pathology of the mouth and its component parts is presented.	
BLOOD AND ITS DISTURBANCES	4
Blood dyscrasias, the clinical use of blood and its component parts, blood types and Rh factors are considered.	
PSYCHOSOMATIC ASPECTS	4
The incidence of psychosomatic factors in clinical medicine requires some background and a therapeutic approach to functional disturbances.	
OTOLARYNGOLOGIC FORUM	30
Evening sessions are devoted to a discussion of the history of otolaryngology, current literature, presentation of papers and general cultural subjects.	
AVIATION MEDICINE	4
The special aspects of barometric pressure differentials in otorhinolaryngology are considered.	
TUBERCULOSIS	6
Clinical demonstration of phthisical lesions of the ear, nose and throat are presented.	

SURGICAL CLINICS	30
Anatomic and pathologic demonstrations are given during the performance of surgical procedures	
PROSTHETICS	8
The indications for and technic of prosthetic replacement of structural defects are demonstrated	
SPECIAL PROBLEMS	100
Assignments are based on interest and aptitude of the student or are designed for those qualifying for a Master's degree in Otolaryngology	
MEDICOLEGAL PROBLEMS	6
Courtroom procedure, expert witness testimony and other aspects are discussed	
CLINIC ROUTINE	
Supervised history taking, examination, diagnosis and treatment of outpatients are given	
SPEECH AND HEARING DISORDERS	60
Consideration is given to the major organic and functional disorders of speech and audition, together with a survey of modern rehabilitative procedures	
MISCELLANEOUS SUBJECTS	100
This material is covered by guest lecturers and demonstrators. In addition, a minimum basic training in ophthalmology is included, which is a part of the working knowledge of the clinical otolaryngologist	

the name of the instructor for each hour. The master plan schedule roughly outlines the entire course and indicates the transition in the character of the subject matter. A sample weekly schedule from each quarter of the school year illustrates this transition (forms C, D and E).

CLINICAL POSTGRADUATE PROGRAM

The purpose of the clinical postgraduate program is to give the trainee the opportunity to translate his theoretic knowledge to functional knowledge, to acquire clinical judgment, technical skill and the self confidence necessary to meet the problems of private, unsupervised practice. The success or failure of this phase of training is dependent on the departmental staff, which must assist, advise and retain responsibility, while seemingly withdrawing from the active management of the clinical material.

Accepted residencies are not always acceptable. There is no established standard for the institution and the resident to meet. The American Medical Association, the American College of Surgeons and the American Board of Otolaryngology may accept a residency as adequate on a rather broad basis. The American Board of Otolaryngology, which is more closely concerned with the quality of the specialty, should not only establish a minimum requirement for residencies but also outline the desirable amplification of those requirements.

FORM C SAMPLE SCHEDULE FIRST QUARTER

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
9 00 to 10 00	Osteology	Anatomy dissection	Didactic otolaryngology	Anatomy dissection	Differential diagnosis	Anatomy dissection
10 00 to 11 00	Bacteriology		Clinical, didactic demonstration			
11 00 to 12 00		Allergy, didactic			Pharmacology	
			Luncheon Period			
1 00 to 2 00	Embryology of the head and neck				Pathology seminar	
2 00 to 3 00		Surgical anatomy	Histopathology	Physiology of speech and hearing		
3 00 to 4 00	Anatomy and Histology of the nose and Sinuses				Microscopy	
4 00 to 5 00		Pathology	Departmental seminar	Pathology		

FORM D SAMPLE SCHEDULE SECOND QUARTER

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
9 00 to 10 00	Otolaryngology, didactic and clinical	Tubercu- losis of nose and throat	Quiz conference	Anatomy dissection	Didactic otolaryn- gology	Physiology of upper respiratory tract
10 00 to 11 00		Microscopy	Clinical, didac- tic demonstra- tion, lecture		Differential diagnosis, clinical	Anatomy dissection
11 00 to 12 00		Allergy				
			Luncheon Period			
1 00 to 2 00	Autonomic nervous system	Labora- tory tech- nics			Anatomy dissection	
2 00 to 3 00	Didactic otolaryngology	Surgery of the head and neck	Histopathology	Physiol- ogy of speech and hearing		
3 00 to 4 00	Interpretation of roentgenograms					
4 00 to 5 00	Surgery of nose and sinuses		Departmental seminar	Psycho- somatic aspects of otolaryn- gology		
5 00 to 6 00					Stomatol- ogy	

FORM E SAMPLE SCHEDULE THIRD QUARTER

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
9 00 to 10 00	Organization and function of a broncho- scopic clinic	Mechanical problems of foreign bodies	Medical aspects of bronchial and pul- monary pathology	Anatomy of tracheobron- chial tree	Medical as- pects of bronchial and pul- monary pathology	Medical aspects of bronchial and pul- monary pathology
10 00 to 11 00	Technic of endoscopy	Anesthesia in peroral endoscopy	Didactic and clinical demonstra- tion	Surgery of the larynx, laryn- gofissure, arytenoid transposition, tracheotomy, laryngectomy	Clinical differential diagnosis	Outpatient clinic, examining technic
11 00 to 12 00	Foreign bodies in air and food passages					
			Luncheon Period			
1 00 to 2 00	Mechanical problems of foreign bodies	Benign tumors of the larynx	Carcinoma of the larynx	Physiology, pathology of bronchial obstruction	Diseases of the larynx in infants and children	
2 00 to 3 00	Relation of up- per to lower respiratory tract infections	Endoscopy, animal hospital	Histopa- thology	Endoscopy, animal hospital	Endoscopy, animal hospital	Endoscopic clinic
3 00 to 4 00	Ward rounds, County Hospital					
4 00 to 5 00		Carcinoma of larynx— principles of therapy	Depart- mental seminar	Pulmonary suppuration, bronchog- raphy inhalation therapy	Pathology of bronchial tumors	

Because of the accelerated postwar program, the department of otolaryngology at the University of Illinois restricted the clinical phase of specialist training to a one year residency. We anticipate that conditions in 1949 will permit us to establish a two year program which will better meet the standard we have set as our objective.

The residency should be divided into two distinct phases, junior (resident fellow) and senior (resident). The resident fellow continues his anatomic study by dissection and by acting as proctor and prosector for the basic postgraduate student. His personal dissection is directed to operative procedures of various types, so that a pattern of action is established before he encounters the living problem. He takes his place in the outpatient clinic where, under the guidance of experienced clinicians, he is inducted into the routine of clinical practice. He is responsible for the history and examination of such patients admitted to the hospital service and for the progress notes to be made. He accompanies the resident and the members of the faculty on ward

rounds After receiving directions and observing technics, he is responsible for changing dressings of surgical patients He acts as second or third assistant at major surgical procedures and as first assistant at minor surgical procedures until he can take over as a surgeon At first, his minor operative procedures will be supervised by a member of the staff or by a resident, who will act as assistant and mentor As his ability increases, his supervision will decrease, so that he will develop a greater sense of self reliance and a true knowledge of his own competence

The resident is responsible for all hospital patients and for the resident fellow He has the aforementioned duties pertaining to the training of his junior He has outpatient clinic duties, particularly in regard to postoperative therapy He responds to requests for consultation from other departments accompanied by a member of the staff, who acts as counselor At major surgical procedures he acts as surgeon, after having had some experience as first assistant Once he assumes the role of surgeon, he maintains it, and a member of the faculty who may scrub with him acts as first assistant, except when invited to illustrate a variation of technic As soon as possible, direct supervision is withdrawn, so that the self confidence may be developed before the resident departs to carry the responsibilities of private practice One of the difficulties encountered in the postgraduate program is in restraining the enthusiasm of the staff for performing operations instead of teaching and directing the surgery We cannot too strongly emphasize this point When, on completing his residency, the otolaryngologist moves to a small community, he should be an experienced, capable surgeon competent to consummate creditably any procedure he will encounter This status he must acquire as a resident, and he can accomplish this end only by performing operations Watching others is a part of his training, but it cannot replace the actual performance of surgical procedures

The residents prepare and present cases at the weekly departmental seminars and enter into the discussion that follows We have established the otolaryngologic forum, which meets in the evening on the second Thursday of the month The forum program is arranged and presented by the residents The subject matter includes the historical background of the specialty, reports from foreign literature and, on occasion, interesting material of nonmedical character All residents in the Chicago area are invited to participate in this and other evening sessions for our residents They are also welcomed at our departmental seminar and at the didactic portions of the postgraduate course of which they are informed through the weekly schedules we send to institutions in the area which have residents in otolaryngology Our residents are

FORM F DIDACTIC AND CLINICAL REFRESHER COURSE **Laryngology, Rhinology and Otology**

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
9 00 to 10 00	Cinematography of ear nose and throat	Otitis media in children	Esophagoscopy	Otolaryngologic aspects of allergy	Management of obstruction of respiratory tract	Acute infections of upper respiratory tract
10 00 to 11 00	Diagnostic procedures	Functional tests of hearing	Osseous complications of rhinogenic origin		Chronic otorrhea	Otogenic, rhinogenic, and pharyngeal complications
11 00 to 12 00	Speech	Audiometry	Obturation of somato prosthesis	Management of bulbar polio myelitis		
12 00 to 2 00	Luncheon Period and Round Table Discussion					
2 00 to 3 00	Surgery of the neck	Aviation medicine	Office procedures	Laryngeal surgery	Stomatology	Nasal fractures
3 00 to 4 00	Antibiotics	Hearing aids	Departmental seminar	Labyrinthine hydrops	Rhinoplastic surgery	Malignant neoplastic disease
4 00 to 5 00	Applied anatomy of the sinuses	Benign tumors of the larynx		Status of labyrinthine fenestration	Hemorrhagic lesions of the nose and mouth	Cancer management
6 45					Informal dinner	

FORM G BASIC REFRESHER COURSE **Laryngology, Rhinology and Otology**

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
9 00 to 10 00	Embryology of the head and neck	Certain basic aspects of pathology	Anatomy of the brain and cranial nerves	Anatomy of the larynx, tracheo bronchial tree and esophagus	Anatomy of the temporal bone	Physiology of the upper respiratory tract
10 00 to 11 00						Anatomic interpretation of roentgenograms
11 00 to 12 00						
	Luncheon Period					
1 00 to 2 00	Review quiz	Review quiz	Review quiz	Review quiz	Review quiz	Review quiz
2 00 to 3 00	Anatomy of the head and neck	Anatomy of the head and neck	Histopathology	Histopathology	Anatomy of the nose and paranasal sinuses	Temporal bone surgery
3 00 to 4 00						
4 00 to 5 00			Departmental seminar			

expected to attend the meetings of the Chicago Laryngological Society on the first Monday of the month. They are encouraged and assisted in the preparation of material for publication. They participate in undergraduate teaching. The transition from student to teacher, which had its beginning in the basic course, is intensified during the residency, so that a new personnel is developed to augment and stimulate our own department and the departments of otolaryngology of other institutions.

FORM H COURSE IN BRONCHOSOPHAGOLOGY, UNIVERSITY OF ILLINOIS COLLEGE OF MEDICINE
First Week

	Monday University of Illinois	Tuesday University of Illinois	Wednesday St. Luke's Hospital	Thursday University of Illinois	Friday Children's Hospital	Saturday St. Luke's Hospital
9 00	Organization and function of a bronchoscopic clinic Room 168	Anesthesia Room 168	Lectures Benign tumors of the larynx Conference room M3	Carcinoma of the larynx Room 168	Disease of the larynx in infants and children	Pathology of bronchial tumors Conference room M3
10 00	Demonstration Technic of laryngoscopy, bronchoscopy, esophagoscopy	Clinic Anesthesia in peroral endoscopy Room 446	Clinic Indications for laryngoscopy Main 10	Demonstration Surgery of the larynx. Laryngo-fissure, arytenoid transposition, tracheotomy, laryngectomy Anatomical Laboratory, 10th floor	Clinic Pediatric clinic in laryngology	Clinic Indications for bronchoscopy Main 10
11 00	Lecture Foreign bodies in the air and food passages					
12 00	Luncheon Period					
1 00	Anatomy and pathology of the larynx Room 168	Mechanical problems of foreign bodies Room 168	Lectures Carcinoma of the larynx. Principles of therapy Room 168	Anatomy of the tracheobronchial tree Room 168	Mechanical problems of foreign bodies Room 168	Clinic (optional)
2 00	Anatomical laboratory 10th Floor	Animal hospital Room 546	Practical Work and Demonstrations Anatomical laboratory 10th floor	Animal hospital Room 546	Animal hospital Room 546	All afternoon sessions Research and educational hospitals, University of Illinois Room 446
4 00	Lecture Relation of upper to lower respiratory tract infections Room 168	Lecture Speech disorders Room 168	Seminar Department of otolaryngology Room 168	Lecture Physiology and pathology of bronchial obstruction Room 168	Lecture Pulmonary sup-puration bronchography inhalation therapy Room 168	

Available residencies to a great extent determine the scope of the educational program in the training of specialists. We have four residencies at the University of Illinois Hospitals and twelve at the Illinois Eye and Ear Infirmary. There are seven residencies at the Veterans Hospital at Hines, Ill., which are closely affiliated with our department. The Cook County, Presbyterian, Michael Reese and St. Luke's Hospitals cooperate with our program by referring their selected residents to us for basic training and by participating in our educational activities.

EXTENSION COURSE

Extension courses in the specialties are divided into two categories. One, the refresher course, covers material the specialist has covered in the past and brings it up-to-date, the other is instructional and pertains to particular subdivisions of the specialty.

**FORM I COURSE IN BRONCHESOPHAGOLOGY, UNIVERSITY
ILLINOIS COLLEGE OF MEDICINE
Second Week**

Monday	Tuesday	Wednesday	Thursday	Friday
Children's Hospital	University of Illinois	St Luke's Hospital	University of Illinois	Children's Hospital
Lecture	Clinic	Lecture	Lecture and Demonstrations	Lecture
Bronchoscopy in infants and children		Endoscopic photography Conference room M3	Surgery of the neck Anatomical Laboratory, 10th floor	Disease of the esophagus in children
Biplane fluoroscopy	Indications for esophagoscopy Room 446	Clinic		Clinic
		Diseases of the esophagus Main 10		Pediatric clinic in esophagoscopy
Clinic	Lecture		Lecture	
Pediatric clinic in bronchoscopy	Hypopharynx anatomy and pathology Room 168		Diseases of the esophagus Room 168	
Luncheon Period				
		Lectures		
Mechanical problems of foreign bodies Room 168	Diagnosis and treatment of bronchial tumors Room 168	Mechanical problems of foreign bodies Room 168	Carcinoma of the esophagus Room 168	Gastroscopy Room 168
Anatomical laboratory 10th floor	Animal hospital Room 546	Practical Work and Demonstrations Anatomical laboratory 10th floor	Animal hospital Room 546	Review of all endoscopic techniques Animal Hospital room 546
Lecture	Lecture	Seminar	Lecture	
Tuberculosis of the bronchus, fungous diseases Room 168	Thoracic surgery Room 168	Department of otolaryngology Room 168	Mediastinitis Room 168	

Refresher Courses—It is well to bear in mind that the refresher course is not intended to teach totally new material. The physician who enters such a course will be disappointed if he seeks knowledge of an unfamiliar kind. The refresher course can only recall the old and add to it the more modern concepts and applications. These courses are fairly standard as to makeup, but the individual subjects may change, and the material of each subject may be handled somewhat differently. Refresher courses divide themselves into the two main divisions of postgraduate training, namely, basic and clinical. The former is designed to meet the needs of two types: the young clinician who has had the basic and clinical training but requires that his knowledge

be refreshed and synthesized for, as an example, the American Board examination, and the old clinician who wants to reenforce the foundation on which his clinical technics are based. The clinical refresher course, while designed primarily for the physician in the small community who has greater difficulty in keeping up with the constant changes that occur in theory and practice, is beneficial to all as a thought-provoking congress of colleagues with similar problems (forms F and G). Another variety of instructional refresher course is that designed to meet the needs of the general practitioner in the community which lacks, or is too small to warrant, the presence of an otolaryngologist. Such a course should emphasize diagnosis, prognosis and treatment and should also indicate the situations which would require the general practitioner to seek specialist aid. It should be a highly practical course, shorn of all theorizing and of all the complex mechanism of abnormal physiology and pathology. It is not a course for specialists, nor is it designed to make specialists of its participants.

Subspecialty and Technical Courses—In addition to the refresher courses, there are the subspecialty and technical courses, designed to give intensive training in a small phase of otolaryngology or to give technical training regarding specific procedures. These courses are necessary because of a lack of sufficient, well balanced residencies covering all phases of training, and because many persons find that the infrequent application of technic tends to dull skill. These instructional courses are short—one to two weeks—and treat a single type of problem. While the variety of courses is great, certain ones have proved popular over a long period and may be considered as standard. They are courses in (1) bronchoesophagology, (2) temporal bone surgery, (3) plastic surgery, (4) neck surgery, (5) histopathology of the ear, nose and throat, (6) hearing rehabilitation and (7) clinical audiometry (Forms H and I present a sample schedule of the course in bronchoesophagology.)

SUMMARY

A review of the requirements of postgraduate education in otolaryngology and certain of the difficulties encountered in meeting the problem reveal the scope of the task ahead. To give one course is relatively simple, to give a series of courses is not too difficult, but the integration of an all-inclusive program requires time, effort and cooperation. The cooperation which must come from the administrative offices of the college and from the other departments cannot be too strongly emphasized. The medical college must recognize its responsibility to the public in providing the postgraduate training of the specialist. It can no longer create the physician and leave to him the task of finding further training.

where and how he can. The examining boards have determined minimum standards, and the medical colleges must meet this minimum with a formal training program. The University of Illinois is cognizant of the broadened academic requirements. It has assisted and supported the departments that assumed the necessary task, and it looks forward to the greater place that postgraduate training is to take in the picture of medical education. The department of otolaryngology will be happy to share the results of its efforts in the developing of programs at other institutions, and it cordially invites criticism that it may improve its own program.

1853 West Polk Street

CHORDA TYMPANI NERVE SECTION AND TYMPANIC PLEXECTOMY

New Technic Used in Cases of Deafness, Tinnitus and Vertigo

SAMUEL ROSEN, M D
NEW YORK

IN a recent issue of the ARCHIVES OF OTOLARYNGOLOGY I¹ reported on a new technic used in surgical fenestration of the labyrinth. This technic consisted of avulsing the chorda tympani from its attachment to the facial nerve and laying it over the fenestra nov-ovalis as a pedicle graft (fig 1). The chorda was thus interposed between the membranous labyrinth and the tympanomeatal flap. The prime purpose of this use of the chorda tympani was to protect the membranous labyrinth and the perilymphatic space mechanically from the untoward effects of blood and inflammatory products coming mainly from the tympanomeatal flap. It was thought that reducing postoperative labyrinthitis in this way might give better hearing results.

All of the first 8 consecutive patients who underwent the chorda tympani nerve graft operation¹ had a decibel loss of 25 or less within two weeks. By the fifth postoperative week the majority had a decibel loss of 15 or less. Of the first 5 patients, in whose cases seven months had elapsed since operation, 3 heard normally (5 decibel loss or less).

When these early results were compared with those of surgeons using the routine fenestration technic it was seen that the results with the chorda tympani technic were 5 to 20 decibels better.

The year end results of all 8 consecutive operations in which the chorda tympani nerve graft was used are reported here (table). Each patient was measured over the full range of frequencies at every examination, but, for simplicity of presentation, the audiometric reading for the 1024 frequency only is given. This reading is representative of the entire range of frequencies. All 8 patients had a successful result (30 decibels or better). Six of the 8 patients had hearing of 15 decibels or better, which can be regarded as normal.

From the Otolaryngological Service, Mount Sinai Hospital.

Read before the Meeting of the Section on Otolaryngology of the New York Academy of Medicine, Dec 15, 1948.

1 Rosen, S. Chorda Tympani Nerve Graft. A Preliminary Report of a New Technique Used in Surgical Fenestration of the Labyrinth, Arch Otolaryng 47:428 (April) 1948.

In certain cases of very severe tinnitus, vertigo and deafness there has been prompt relief of symptoms after a one stage operation combining fenestration, section of the chorda tympani and tympanic plexectomy

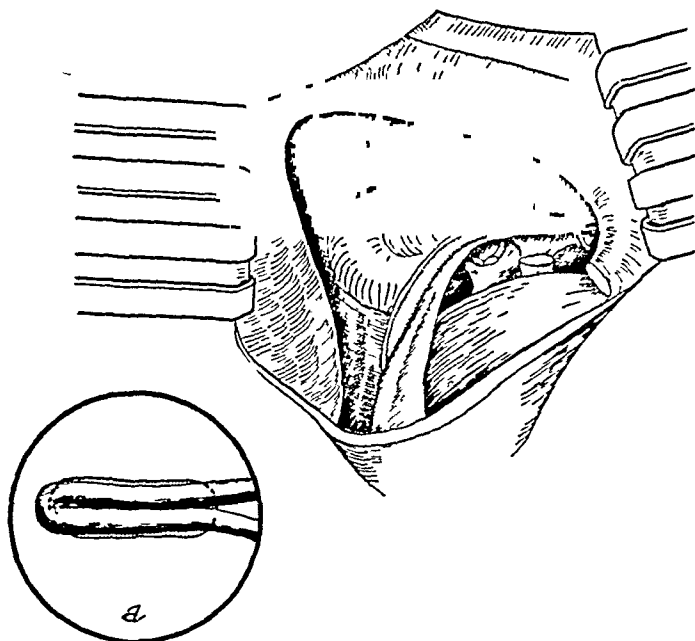


Fig 1—The chorda tympani nerve covers the membranous labyrinth in the fenestra

TECHNIC

The chorda is freed from the drum and avulsed from the facial nerve. After the tympanomeatal flap is completed and placed in its final position, an incision

Audiometer Reading at 1024 in 8 Consecutive Cases in Which the Chorda Tympani Nerve Graft Technic Was Used

	F W	N R	P S	R T	M B	M L	B A	D S	
Preoperative	50	60	50	65	60	45	55	55	
Postoperative 2 wk	25	Clot	20	25	25	25	25		Median 25
3 mo	Otitis	Head cold	10	15	15	10	15	25	10
6 mo		5	10	25	10	10	5	25	10
9 mo	5	5	10	30	5	10	15		10
12 mo	5	5	10	25	10	15	15	30	13

is made through the meatal skin about 3 mm from the drum beginning at 2 o'clock on the right side or 10 o'clock on the left side and ending at the inferior free edge of the tympanomeatal flap. The tympanic membrane with attached meatal skin is then carefully lifted out of its annulus and reflected above, bringing into view the hypotympanum, the inner tympanic wall, the tympanic plexus, the eustachian tube, the inner aspect of the malleus, the tendon of the tensor tympani

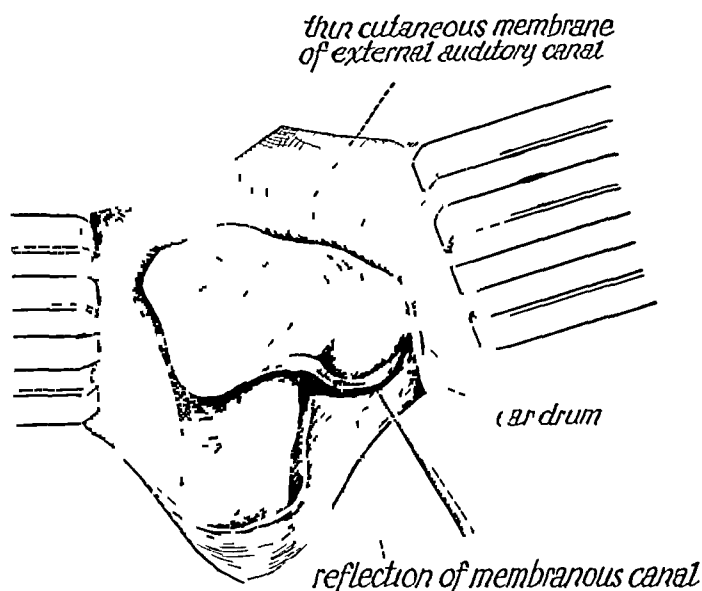


Fig 2—After the tympanomeatal flap is completed the skin of the canal close to the drum is incised from 2 o'clock on the right side or 10 o'clock on the left side to the inferior free edge of the flap

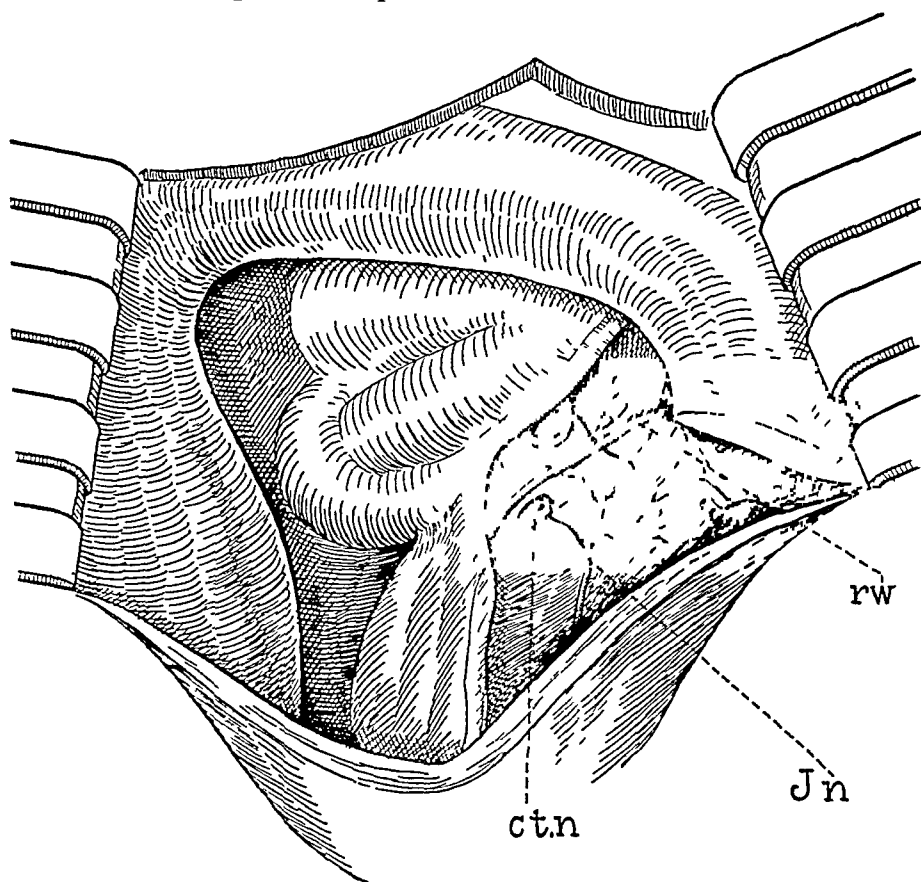


Fig 3—The tympanic membrane is lifted out of the annulus and reflected upward along with the rest of the flap thus exposing the tympanic cavity *J N* indicates Jacobson's nerve, *rw*, the round window, *ctn*, the chorda tympani

muscle, the round window, the entire stapes and the facial nerve. The plexectomy may now be performed with ease and in full view with appropriate dental scraping instruments (figs 2 and 3). By this technic the inner tympanic mucosa and Jacobson's nerve can now be adequately removed for histologic study. Figure 4 is a section of a portion of the tympanic plexus removed during operation. It was prepared and studied by Dr. Joseph H. Globus. He reported as follows: "The scraping from the inner tympanic wall on microscopic examination contains several small nerve trunks cut on cross section. Here and there are structures simulating nerve fibers in oblique plane. They are embedded in fairly dense connective tissues with islands of bone irregularly distributed in the field."

The fenestra is then made and is covered with the chorda, and the tympanomeatal flap is placed in its final position.

In some instances section of the chorda and destruction of Jacobson's nerve alone may be desirable, without fenestration of the labyrinth. They can be done



Fig 4—Section of the tympanic plexus removed from a patient

easily through the external auditory canal in a way similar to that described by Lempert² except that the incision made through the posterior canal wall should begin at 10 o'clock on the right side and 2 o'clock on the left side. After the drum is reflected upward the chorda tympani can be seen traversing the tympanum upward just internal and behind the bony annulus. With a dental hook it can be pulled outward and sectioned (fig 5).

REPORT OF CASES

CASE 1—F. L., a 42 year old married woman, with one child, had noted progressive deafness in both ears since the age of 17. Bilateral tinnitus began at that time and increased along with the deafness. Even though the deafness became

² Lempert, J. Tympanosympathectomy. A Surgical Technic for the Relief of Tinnitus Aurium, *Arch Otolaryng* 43:199 (March) 1946.

profound, the constant roaring and hissing tinnitus persisted and increased in intensity until during the past three to four years it became unbearable. The tinnitus was always worse in the right ear. She sought relief only for the tinnitus. Inasmuch as the fenestration performed for otosclerosis often relieves tin-

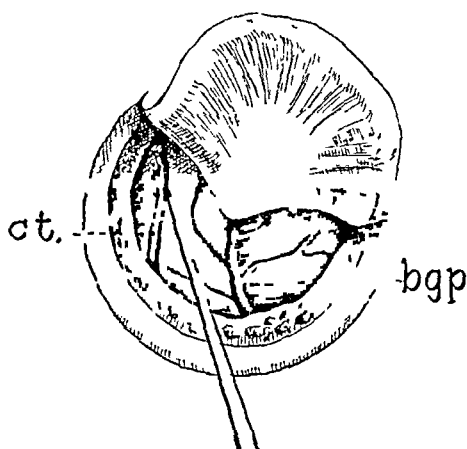


Fig 5—Tympanic denervation and section of the chorda tympani (*c t*) performed through the external canal, *b g p* indicates the bony grooves of the tympanic plexus

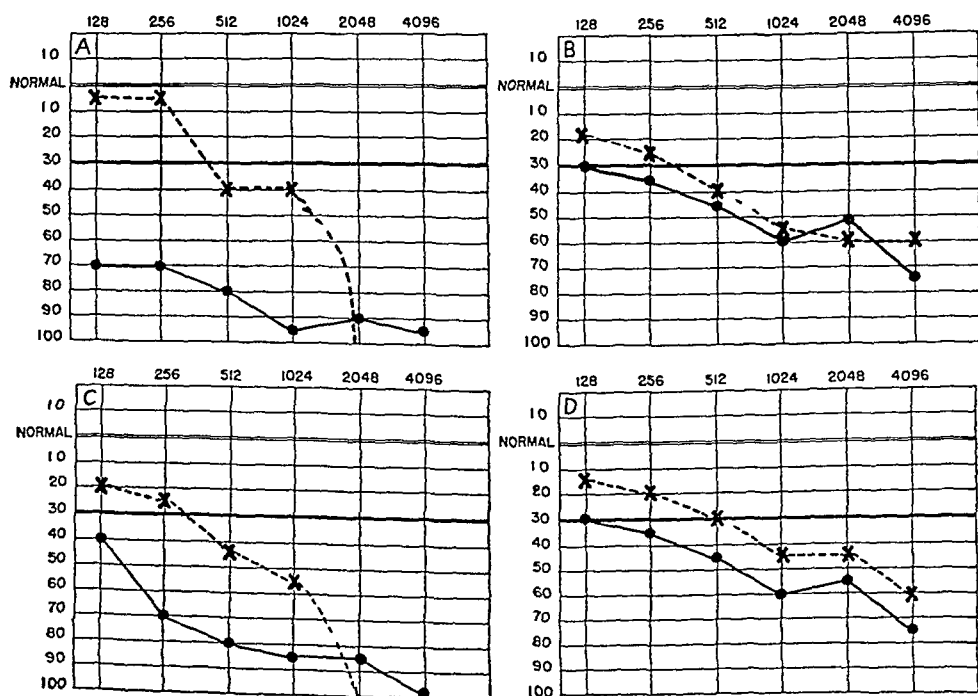


Fig 6—Audiograms of F L (case 1) *A*, preoperative thresholds of the right ear, *B*, those obtained eleven months after the operation, *C*, preoperative thresholds of the left ear, *D*, those obtained three months after the operation. Crosses represent the hearing for air conduction, circles, that for bone conduction

nitus and because occasional good results had been reported with "tympano-sympathectomy," I decided to try combining both procedures—finally covering the fenestra with the chorda tympani. This was done on the right ear, July 29,

1947 The stapes was fixed. The patient's tinnitus disappeared at once and she states that the hearing has improved so that she can use the telephone now for the first time in many years. In figure 6 audiogram *A* shows the preoperative thresholds of hearing and audiogram *B* the thresholds eleven months after the operation.

One year later, the left-sided tinnitus became increasingly unbearable, and on July 19, 1948, at the patient's request, fenestration and tympanic plexectomy were done. The chorda was left intact on this side. The patient's tinnitus has diminished markedly on this side but has not completely disappeared. However, she has no complaints.

In figure 6 audiogram *C* shows the preoperative thresholds and audiogram *D* the thresholds three months after the operation.

CASE 2—L S, 21 years old, the mother of a 4 month old baby, had progressive bilateral deafness for a few years with intermittent high-pitched tinnitus, much greater in the right ear. For one and a half years prior to examination she had attacks of vertigo every few weeks with constant tinnitus in the right ear. There was no tinnitus in the left ear. The attacks of vertigo in the past eight months had increased in severity and frequency until she could not attend her infant. Some of the vertiginous episodes were accompanied by nausea and

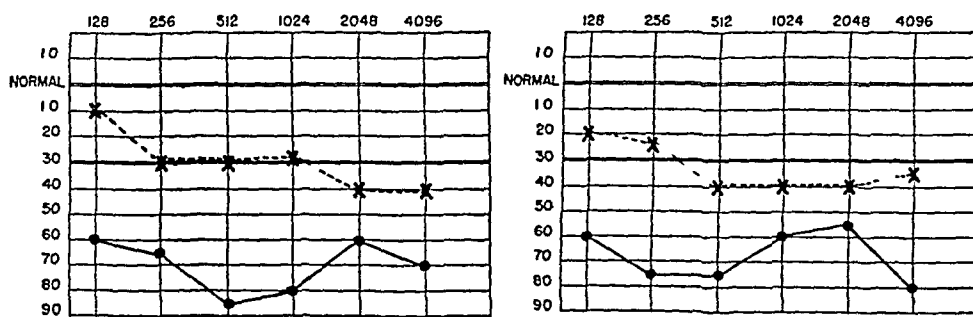


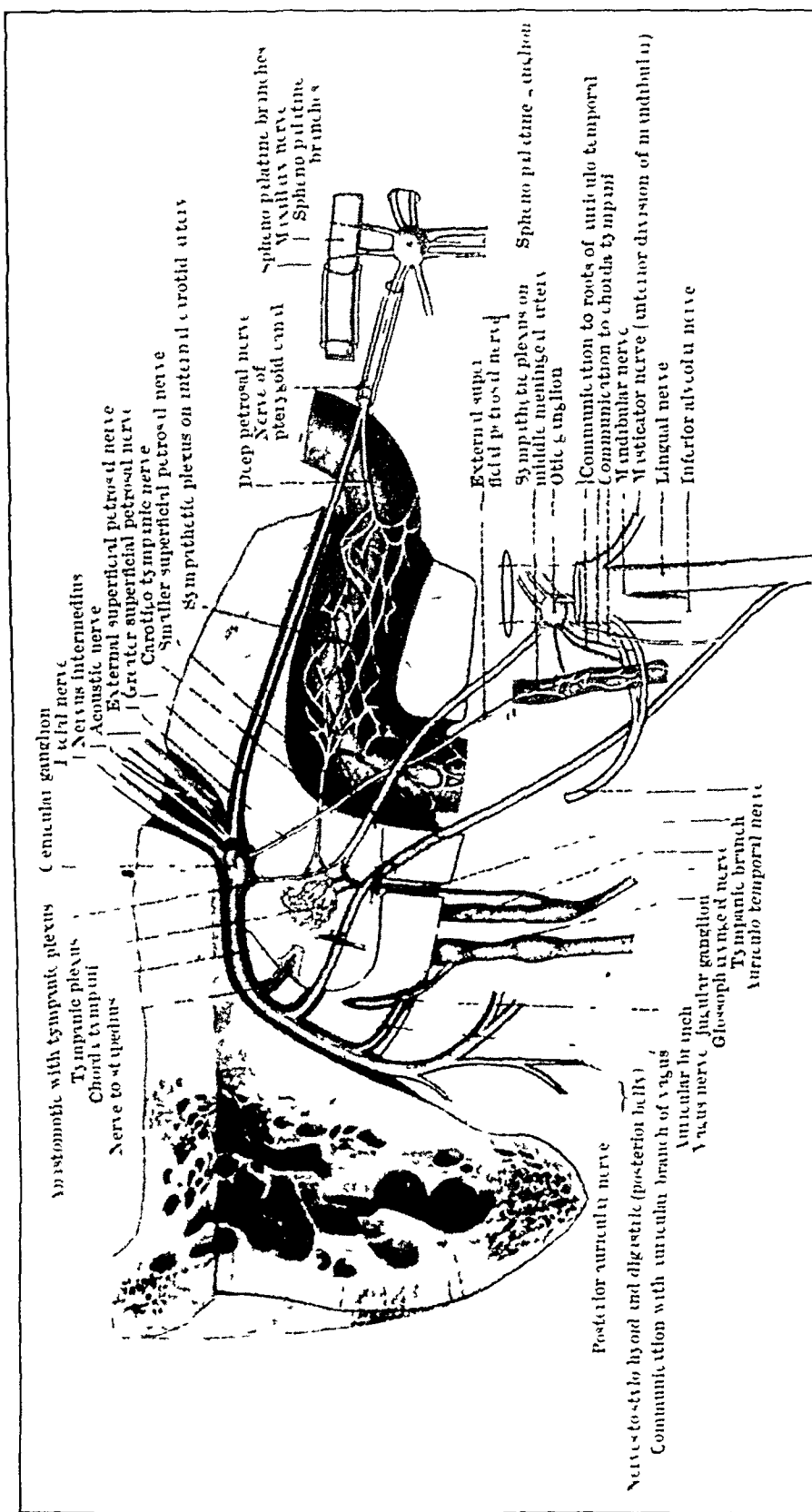
Fig 7—Audiograms of L S (case 2) chart at left, preoperative thresholds of the right ear, chart at right, thresholds eight months after the operation. Crosses represent the hearing for air conduction, circles, that for bone conduction.

vomiting and lasted several hours. Caloric responses were slightly less marked on the right. On March 16, 1948, a one stage procedure including fenestration, tympanic plexectomy and section of the chorda was done. The stapes was fixed. Since the initial surgical vertigo, which was present during the first ten days after the operation, there has been no vertigo or tinnitus. If the vertigo and the tinnitus had persisted, destruction of the entire membranous labyrinth could have been done subsequently.

In figure 7 the audiogram on the left side shows the preoperative thresholds of hearing and the audiogram on the right the thresholds eight months after the operation.

In casting about for a possible explanation for the phenomena observed in the cases in which the chorda tympani nerve graft was used and the cases described in this paper, I encountered the theoretic work of Dr Daniel E. Schneider³ on a new theory of hearing. The essence of this concept is that there are two sonic systems in man—one the

³ Schneider, D. E. VI The Growth Concept of Nervous Integration, *J. Nerv. & Ment. Dis.* **105** 124 (Feb) 1947.



more recent cochlea and the other the older, primitive sonic system derived from the lateral line organs of aquatic vertebrates. In these primitive animals the seventh and ninth nerves carry the sonic and equilibratory impulses to the brain stem. This primitive internal sonic system includes the connections between the petrosal and the geniculate ganglion. Schneider and Brodsky⁴ had shown, on the basis of dental pathology, that there was a possibility that the tympanic plexus could be reflexly stimulated to produce tinnitus and possibly vertigo. They suggested denervation of the tympanic plexus.

The chorda tympani and the tympanic plexus are derivatives of this primitive system. The chorda tympani is the continuation of the nervus intermedius which, according to Cunningham's⁵ "Textbook of Anatomy," communicates with the vestibular branch of the eighth nerve in the internal auditory canal. It is possible that the old sonic system is connected with the newer sonic system via the geniculate

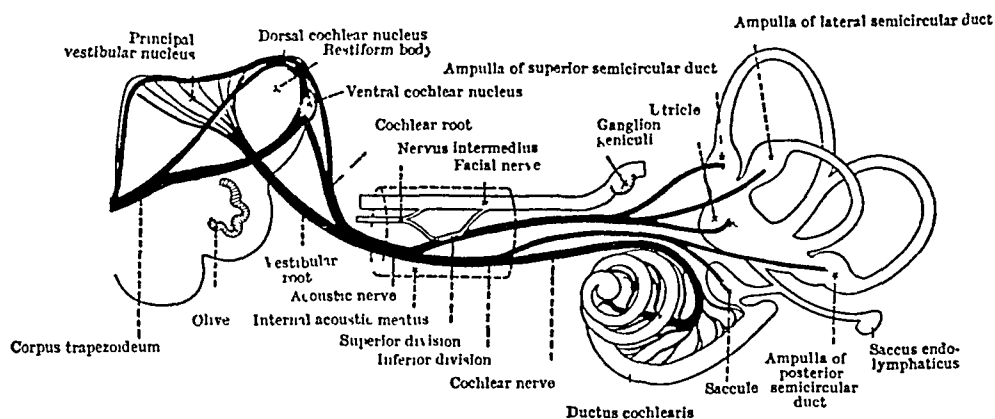


Fig 9—Scheme of the origin and distribution of the acoustic nerve. Note the branch of the nervus intermedius communicating with the vestibular portion of the eighth nerve in the internal acoustic canal. (From Cunningham⁵)

ganglion. Impulses in the chorda tympani could thus find their way into the labyrinth (figs 8 and 9). At present this is only a hypothesis but it should perhaps be fully explored.

According to Schneider's concept, the internal sonic system operates normally at a high inaudible frequency and cooperates with external hearing. Therefore, the hearing of external sound is not ordinarily interfered with by the internal sonic system. In the various syndromes of deafness, tinnitus and vertigo this primitive sonic system becomes irritated or deficient. As a result, internal vegetative sound, normally unheard, probably becomes audible. As the stapes becomes fixed,

4 Brodsky, R. H. Tympanic Plexus Tinnitus Versus Reflex Dental Tinnitus, *New York J. Dent.* **16** 108 (March) 1946.

5 Cunningham, D. J. *Cunningham's Textbook of Anatomy*, ed. 8, London, Oxford University Press, 1944.

external sound is shut out. Then the sound from the primitive system becomes louder. As the deficiency or the irritation of the internal sonic system progresses, the tinnitus thus set up becomes increasingly severe. Because the chorda which supplies the anterior two thirds of the tongue with taste is connected with the nervus intermedius through the geniculate ganglion, it is entirely possible that stimulation of the chorda tympani may affect vestibular function directly and cochlear function indirectly.

In the light of this, the procedure of section of the chorda and tympanic plexectomy would constitute a partial denervation of the internal sonic system. In searching the literature I have found no other theory postulating an internal sonic system which includes the chorda tympani as an important element. Otolaryngologists are all familiar with Costen's⁶ syndrome in which a malfunctioning temporomandibular joint gives rise to unilateral tinnitus and glossodynia. These symptoms subside on correction of the bite. Seydell⁷ reported on 175 cases of Costen's syndrome in which among other symptoms, there were tinnitus (69 cases), deafness (68 cases), vertigo (31 cases) and symptoms of involvement of the tongue (27 cases). These symptoms are presumably in part due to compression of the chorda tympani nerve in its close proximity to the malfunctioning jaw joint, and perhaps to irritation of the tympanic plexus.

The procedure, therefore, of cutting the chorda tympani and using it as a graft to protect the membranous labyrinth may thus produce a twofold effect: on one hand, mechanical, protective and, on the other physiologic, in that irritative impulses traveling to the labyrinth via the chorda are thus interrupted.

One might object to the emphasis on the chorda as having some beneficial effects in the cases reported by pointing to fenestration alone as capable of producing such effects. However, I am reporting this because in my experience fenestration alone and various mechanical refinements have not produced as speedy a return of good hearing or such a high degree of recovery of hearing, or such a dramatic abolition of vertigo. From the quality of the results thus far I suspect that section of the chorda tympani may have a profound influence on the internal state of the labyrinth and may have contributed to the

6 Costen, J. B. A Syndrome of Ear and Sinus Symptoms Dependent upon Disturbed Function of the Temporo-Mandibular Joint, *Ann Otol, Rhin & Laryng* **43** 1 (March) 1943.

7 Seydell, E. C., in discussion on Woodward, F. The Use of a Temporary Inexpensive Bite Block to Determine the Relationship of a Closed Bite and Temporo-Mandibular Joint Symptoms, *Tr Am Otol Soc* **31** 145, 1941.

unusual hearing results in 8 cases observed over a period of a year. Further research in this direction is in progress to test this hypothesis. Finally, it must again be emphasized that only after long and perfected practice on the cadaver should any of these procedures be attempted on the living patient.⁸

⁸ Rosen, S. Learning the Lempert Fenestration Operation, *Arch Otolaryng* **45** 335 (March) 1947. Maxwell, J. H. Training of Surgeon and Selection of Patient for the Fenestration Operation, *ibid* **46** 539 (Oct) 1947.

REHABILITATION OF THE LARYNX IN CASES OF BILATERAL ABDUCTOR PARALYSIS

Open Approach to Arytenoidectomy, with Report of the Past Four Years' Experience

DE GRAAF WOODMAN, M D
NEW YORK

AT THE Annual Session held in San Francisco in 1946, Dr Joseph D Kelly,¹ of New York, addressed this Section on the subject of laryngeal surgery for bilateral abductor paralysis. In his paper he made the following statements:

One can sum up the situation in regard to bilateral abduction muscular paralysis by saying that there are two definite surgical procedures which have been tried and not found wanting according to statistics of successful results up to the present time. There is the posterior approach of Dr [Brien T] King² with the attendant mobilization and fixation of the arytenoid cartilage to the alae of the thyroid cartilage. And the second procedure may be described as the arytenoidectomy in which a direct approach is made to the arytenoid cartilage through a window made in the thyroid cartilage.

Many have agreed with Dr Kelly that arytenoidectomy is preferable to rotation and lateralization of the cartilage, but have not accepted his window approach as offering sufficient room for such a meticulous dissection. To the inadequate exposure are added the difficulties of hemostasis, which may occur in such a restricted field.

To those who prefer a wide exposure, the open, posterior approach³ has had its appeal. This is achieved by releasing the thyroid cartilage from its cricothyroid joint, permitting a 1½ inch (3.8 cm) exposure of the operative field. This approach, together with the technic for the removal of the articular part of the arytenoid cartilage and the lateralization of the vocal cord to the thyroid cartilage, has been used by several

Read before the Section on Laryngology, Otology and Rhinology at the Ninety-Seventh Annual Session of the American Medical Association, Chicago, June 23, 1948.

1 Kelly, J. D. Surgery of the Larynx in Bilateral Abductor Paralysis, J. A. M. A. **134** 944 (July 12) 1947.

2 King, B. T. A New and Function Restoring Operation for Bilateral Abductor Cord Paralysis. Preliminary Report, J. A. M. A. **112** 814 (March 4) 1939. Morrison, L. F. Further Observations on the King Operation for Bilateral Abductor Paralysis, Ann. Otol., Rhin. & Laryng. **54** 390 (June) 1943.

3 Woodman, De G. A Modification of the Extralaryngeal Approach to Arytenoidectomy for Bilateral Abductor Paralysis, Arch. Otolaryng. **43** 63 (Jan) 1946.

laryngologic surgeons during the past four years with successful results in a series of cases

PROCEDURE

If a preliminary tracheotomy has not been done, the patient is prepared with use of local anesthesia, with the placement of an intratracheal tube (under guidance of the laryngoscope) The tracheotomy may then be performed with local anesthesia, or intravenous anesthesia may be started and the tracheotomy done with the patient under general anesthesia

1 After tracheotomy, an incision is made along the anterior border of the sternocleidomastoid muscle at the level of the upper edge of the thyroid cartilage and carried down to the level of the cricoid cartilage (The transverse incision, located one-third the way down from the upper edge of the thyroid cartilage, is optional)

2 The sternocleidomastoid muscle is retracted, exposing the posterior edge of the lateral thyroid cartilage, with the thyrohyoid muscle attached anterior to its posterior edge and the inferior pharyngeal constrictor muscle attached to its posterior edge and to the inferior cornu The attachment of the inferior cornu to the cricoid cartilage is a key landmark

3 A vertical incision is made along the posterior edge of the lateral thyroid cartilage and the inferior cornu down to and through the perichondrium The inferior constrictor muscle is separated posteriorly, the cartilage is hugged closely, and the perichondrium is elevated around the posterior edge onto its mesial side sufficiently to free it of attachments to the inferior constrictor muscle

The facet-like joint between the inferior cornu and the cricoid cartilage is then separated The incision is carried through the perichondrium on the lateral wall of the cricoid cartilage and continued vertically upward until the subperichondrial dissection of the arytenoid cartilage has been accomplished When dissection of this structure has been done, the joint is disarticulated A traction ligature is then placed around the middle portion of the arytenoid cartilage, and the cartilage is rotated laterally With the aid of this traction ligature, the vocal process can be well exposed A curved atraumatic needle with 0 chromic surgical gut is passed around the vocal process, care being taken to keep it in the submucosa and to pass it through and to include some of the fibers of the vocalis and the thyroarytenoid muscles After placement of this suture, all the arytenoid cartilage is removed except the nonarticular part associated with the vocal process The cord suture is then drawn laterally and tied around the inferior cornu of the thyroid cartilage, and this, in turn, may be reenforced by anchoring the suture to the anterior edge of the sternocleidomastoid muscle

If the attachment of the cord to the inferior cornu should cause too much lowering of its horizontal plane, this fault may be overcome by the optional attachment through a $\frac{1}{8}$ inch (0.32 cm) drill hole anterior to the posterior edge of the thyroid cartilage at the desired level

Before the wound is closed the larynx is inspected with the laryngoscope and careful note made of the position of the cord

Closure is made by bringing the inferior constrictor muscle back into place with a few separate sutures. Interrupted sutures close the skin, a Penrose drain being left in the lower end of the wound and removed on the fourth postoperative day

ANALYSIS

An analysis was made of the data on 24 cases contributed by eight laryngologic surgeons. Fifteen of these cases came under my own observation, either at operation or at the follow-up examination. Nine cases were contributed in response to a questionnaire sent to other surgeons who performed this operation

In all but 3 of these cases the abductor paralysis resulted from paralysis of the vocal cords after thyroidectomies. The twenty-sixth postoperative day was found to be the average time at which the tracheotomy tubes might be removed. In a case of a disturbance diagnosed as psychoneurosis, anxiety state, the patient still wears a tube in spite of adequate airway, as proved by laryngoscopy and bronchoscopy and by full corking. In only 4 cases was a feeding tube needed after operation

The voice was found to be better in 13, adequate in 9 and worse in 2 cases. A glottic chink of 3 to 5 mm resulted in a better voice, as a rule, whereas with a 5 to 6 mm space the voice was adequate. Those patients with poor voices are well satisfied as improvement in the airway was primarily desired, the voice being of secondary importance to them

COMMENT

It has been said that this method offered so much trauma to tissues that a feeding tube was needed. This has not been my experience in this series, as only 4, or 16 per cent, of these patients used feeding tubes. Traumatic edema may be the result of manipulation inside the larynx attendant on difficulties of laryngoscopy, rather than of any external work on laryngeal cartilages

The problem is to learn how to plan more accurately and to obtain the exact spacing desired, which will not only give better airway but also maintain the best possible voice

The following important factors are to be considered (1) width and shape of thyroid cartilage (Is it oval, "u," or "v" shaped?), (2)

whether cartilage is calcified and rigid or flexible, (3) the level at which the transfixion suture in the vocal cord is placed and (4) any distortion of the larynx or trachea

The correct glottic space can probably be more accurately obtained if the aforementioned factors are kept in mind. This may come with experience, together with close attention to details already learned and careful check with the laryngoscope before final closure of the wound

SUMMARY

Several satisfactory technics exist for the correction of this laryngeal problem. The posterior open approach to arytenoidectomy is presented, with its quota of cases of successful results, as a method which appeals particularly to those who desire good exposure of the operative field

The following surgeons contributed cases to this series: Dr D C Baker, Dr H S Friedman, Dr A D Ghiselin Jr, Dr J D Kernan, Dr F E LeJeune, the late Dr J O MacDonald, Dr F D Woodward and Dr De Graaf Woodman

ABSTRACT OF DISCUSSION

DR PAUL H HOLINGER, Chicago. The contribution Dr Woodman has made to the surgical repair of bilateral abductor paralysis is an important one. Adequate exposure is a fundamental surgical principle, and he achieves it with the approach he describes. The procedure apparently has been well tested, in view of the number of patients so treated. Of further significance is the fact that Dr Woodman did not mention any case in which operation had also been performed on the opposite side because of failure of the first operation to give an adequate airway. I should like to ask whether a second operation has had to be performed in any of his cases.

One wonders why Dr Woodman is so reluctant to use a feeding tube when pain, temporary dysphagia or arytenoidal edema makes the patient refuse liquids or solids. It is important, of course, to pass the tube down the contralateral side of the pharynx to keep it away from the site of operation. Otherwise, I can see no disadvantage to the feeding tube and do not understand why its use should be considered a criticism of his excellent surgical approach.

I agree with Dr Woodman in his use of intratracheal anesthesia for this operation. It seems to have every advantage and no disadvantage. My associates and I have used this technic for many years and find it permits easy and repeated, if necessary, examinations of the larynx throughout the operation.

The approach we have used for this transposition of the arytenoid cartilages or arytenoidectomy is that described by Seed and Galloway, which, after all, is another modification designed to improve exposure. We have made a practice of passing the suture around the base of the superior horn rather than the inferior horn, as Dr Woodman does, but the ultimate purpose is similarly accomplished. Of a total of 42 cases, we have operated in 31 with this technic, and the tube has been removed in 26 of them. In 5 cases the tracheotomy tube was retained, and the patient did not wish any further operative treatment, and in 11 cases surgical intervention was refused, the patient feeling that the airway was adequate and that he did not wish to risk any reduction in voice.

Dr Woodman made no mention of the medical phase of this problem, I should like to ask him whether the medical aspect has been as prominent a factor in his cases as it has in ours. Pronounced hypothyroidism and hypoparathyroidism have been associated phenomena in almost all of our cases, and the condition should be corrected before operation, for best results. Dr Robert Keeton first pointed out this medical problem in our cases, and we find it as serious as the surgical aspect of the condition. The cholesterol and calcium levels must be maintained after operation, too, or the myxedematous infiltration and the spasms associated with tetany will cancel the improvement in the airway obtained surgically.

DR FLETCHER D WOODWARD, Charlottesville, Va. I have operated on 7 patients who had bilateral paralysis of the recurrent laryngeal nerve after operation on the thyroid. The first patient had a Kelly operation on one side, with satisfactory result, the second required a bilateral Kelly operation to obtain an adequate airway, the third had a Kelly operation on one side and an Orton operation on the other before an adequate airway was obtained. The fourth patient had a Kelly operation on one side, but on the other a Woodman operation was required, which was so successful that the fifth, sixth and seventh patients each had a Woodman operation on one side, in each instance the voice was preserved and an adequate airway was obtained. A total of nine operations were required on the 7 patients.

This operation gives such an adequate exposure that the surgeon is able to visualize every minute detail and can execute the various steps with precision and assurance. In my limited experience with four such operations, the results were uniformly good in that the voice was preserved and an adequate airway established. One of my patients recently experienced acute inflammatory laryngitis, but had no dyspnea during the attack. A feeding tube is unnecessary after operation, recovery is prompt, and decannulation can be carried out in four to six weeks.

DR DAVID R HIGBEE, San Diego, Calif. Dr Woodman stated that in a certain percentage of cases the operation, although successful, was not accompanied with satisfactory voice. I want to ask whether to any extent this was due to a failure to finish the operation with both vocal cords at the same level. Did one override or underide the other?

DR DE GRAAF WOODMAN, New York. In answer to Dr Holinger's question about an operation on the opposite cord. It is true that it has been needed in a few cases. I did not perform such an operation myself, but I know of 2 cases in which it was necessary in order to obtain adequate airway. In both cases a good airway was obtained and a tracheotomy tube was not needed, but the voices were poor.

I see no harm in the use of a feeding tube, though I have never had to use one, but we were criticized by Dr Kelly for the need of a feeding tube after this procedure.

In all cases reported intratracheal anesthesia was used.

Dr Seed gave an excellent description of a posterior approach, though he did not indicate in his procedure or in his illustrations what I feel to be the key to the success of this particular exposure, namely, the release of the inferior cornu from its attachment to the cricoid joint. It would seem to me that the superior cornu is a little too high to be used. The correct lateralization and level vary with each case, depending on the size, shape and rigidity of the thyroid cartilage. In 1 case the inferior cornu was fractured while being retracted. I was able to lateralize the cord at the exact level desired by drilling a $\frac{1}{8}$ inch (0.32 cm) hole in the

posterior edge of the thyroid cartilage. Correct lateralization is a matter of experience and depends on the shape and size of the thyroid cartilage. As to the medical aspects, I feel that the patient should first have the benefit of a tracheotomy, after this, medical care should be even more rapid in its stabilizing effect.

Dr Woodward's incision has merit, particularly in cases of scarring from previous thyroidectomies. With this incision it is easier to find the superior edge of the thyroid cartilage.

In answer to Dr Higbee's question I consider an adequate voice one which can be well understood over the telephone.

While the level is important, the extent of lateralization is much more so. Some patients apparently have a change of 2 to 3 mm in the level of the cords and one of 3 to 5 mm in the posterior glottic chink. These are among the best for voice and airway. If lateralization is not sufficient, a change in the level may give the needed airway.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

CHRONIC PROGRESSIVE DEAFNESS, INCLUDING OTOSCLEROSIS AND DISEASES OF THE INNER EAR

Review of the Literature for 1946

ARTHUR L. JUERS, M.D.

EUGENE L. DERLACKI, M.D.

AND

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THE MAJOR portion of the 1946 literature on deafness is concerned with the problems of the surgical treatment of otosclerosis and with further observations on acoustic trauma and aerotitis. As in previous years, this review includes only those articles which give some new information relative to the problem of deafness. The material is arranged as follows:

Otosclerosis

Pathology

Treatment

Deafness Due to Lymphoid Hyperplasia of the Nasopharynx

Treatment of Aerotitis

Deafness Due to Trauma

Psychogenic Deafness

Meniere's Syndrome

Miscellaneous Contributions on Causes and Treatment

PATHOLOGY OF OTOSCLEROSIS

Wojniak¹ compared the external ear canal and drum membrane of 100 patients with otosclerosis with 70 normal ears and 30 with nerve deafness as to (1) size of the external auditory canal, (2) cerumen, (3) condition of the skin in the canal, (4) sensitivity, (5) cough reflex, (6) vascular reflex, and (7) condition of the drum membrane as to thinness and transparency, Schwartz's sign and mobility of the malleus and pars tensa. He concludes that,

except for Schwartz's sign, which is present twice as often in otosclerosis as in other forms of deafness, and five times as often in otosclerosis as in normal hearing individuals, and the apparent absence of mobility of the handle of the malleus in a greater proportion of patients with otosclerosis than of the controls, there is

¹ Wojniak, F. The External Ear and Drum Membrane in Otosclerosis, *Ann. Oto., Rhin. & Laryng.* **55**: 406-419 (June) 1946

nothing characteristic in the external ear and drum membrane in otosclerosis to help in its differentiation from other forms of deafness

In his microscopic studies of temporal bones with otosclerosis, Hagens² could not confirm the observations of Gray regarding the loss of neurokeratin in the medullary sheaths and neurilemma of the cochlear nerve to explain the clinical findings of inner ear deafness frequently associated with otosclerosis. As an explanation of Schwartz's sign, he observed congested large vessels under the epithelium of the promontory overlying an otosclerotic focus.

TREATMENT OF OTOSCLEROSIS

Walsh and Silverman³ point out that many variables influence the reliability of bone conduction tests and thereby lessen their dependability as a means of assessing cochlear function. They believe that the P B test, consisting of series of words developed at the Psycho-Acoustic Laboratory of Harvard University, has advantages over the usual bone conduction tests for this purpose. In this speech articulation test the words are given at increasing intensity, and in a person with a normal ear or with pure conduction deafness the articulation score climbs up to 100 as the intensity increases. In the presence of nerve deafness, however, there is no increase in the articulation score beyond

Walsh and Silverman feel that there are two objections to depending solely on pure tone audiometry for evaluation of results. First, thresholds for pure tones are not always adequately indicative of auditory function above threshold. Second, in the calibration of pure tone audiometers consideration is not given to the fact that the air space of the fenestration cavity is added to that of the normal canal. These authors advocate that the articulation score be tested at the 20, 35 and 50 decibel intensity level. An average is made of the articulation scores obtained. They suggest that if this average score is 50 or better the subject may be considered to have been socially rehabilitated. These tests are all above threshold and should show how the ear functions over a wide dynamic range of speech intensities. If a speech threshold test alone is obtained Walsh and Silverman state that when a person has a loss of 35 decibels or less he is considered to be socially adequate. However, they feel that if there is any significant associated nerve involvement the threshold test will not alone predict social adequacy.

² Hagens, E. W. Pathology of Otosclerosis, Quart Bull, Northwestern Univ. M. School **20** 192-198 (March) 1946

³ Walsh, T., and Silverman, S. R. Diagnosis and Evaluation of Fenestration, Laryngoscope **56** 536-555 (Sept.) 1946

Of the patients presenting themselves to the Mayo Clinic because of deafness, Williams⁴ was able to make a diagnosis of clinical otosclerosis in approximately 20 per cent. Of these, not more than 50 per cent were suitable for the fenestration operation. Williams believes that pure tone audiometry should be supplemented by fork tests in diagnosis and evaluation of cases as to suitability. In the ideal case the forks should be heard by bone conduction ten to fifteen seconds longer than by air for the 512 fork and eight to ten seconds longer for the 1024 fork and the audiometric curve should not show evidence of cochlear atrophy. In these cases there is about a 70 per cent chance of restoring the hearing to a practical level, but in 10 to 15 per cent of these the fenestra will close sooner or later. If there is evidence of cochlear degeneration, the chances are less, depending on the degree of nerve atrophy.

Lindsay⁵ observed in the histologic studies of his experimental fenestrations on monkeys that the osteogenetic activity of the periosteal layer of the labyrinthine capsule seemed to be the most rapid and to be chiefly responsible for early closures. Osteogenesis from the endosteal layer proceeded more slowly, while the enchondral layer rarely participated in the process to any significant degree.

When a conjunctival or cutaneous graft was placed between the tympanomeatal flap and the fistula, new bone appeared only in opposition to old bone—never between the graft and the covering flap. In general, Thiersch grafts taken from the scalp were not satisfactory, as about a third of them degenerated with closure of the fistula the rule. Fragments of hair tended to promote callus formation. In some of the fistulas covered with Thiersch grafts, patency was maintained four or five months after operation. Of five fistulas covered with conjunctival grafts with the epithelium against the bone, the epithelium degenerated in 2 instances. In the other 3 the osteogenetic activity of the periosteal bone was apparently inhibited or prevented. In another ear, in which the conjunctival graft was placed with the epithelium outward, the graft remained viable and the fistula patent. Although histologic observations are only partly available, Lindsay found the tympanomeatal flap employed according to the Lempert technic to be fairly effective in inhibiting osteogenesis, provided the margin of the fistula was on a convex surface rather than in a localized concavity.

Lindsay's observations suggest the probability that osteogenetic closure arising from the endosteal layer is diminished by completely removing endosteal bone fragments and endosteal shreds from the

4 Williams, H. L. Selecting Patients for the Fenestration Operation, *S Clin North America* **26** 876-889 (Aug.) 1946

5 Lindsay, J. R. Histologic Observations on the Healing of Labyrinthine Fistulas in Monkeys, *Arch Otolaryng* **43** 37-48 (Jan.) 1946

fistula, contouring the fistula to permit uninterrupted contact between the membranous canal and the flap and avoiding separation of the endosteum from the bone deep to the margin of the fistula. He believes that bony fragments act by depressing the membranous canal away from the flap rather than actively participating in the osteogenic process.

The experimental and clinical basis of modifications of the original Lempert fenestration technic is discussed by Shambaugh and Juers.⁶ A decrease in the incidence of closures to less than 5 per cent has been accomplished by carrying out the following points of technic:

- 1 Enchondralization of the fistula. The enchondral layer of the labyrinthine capsule is widely exposed in the vicinity of the fistula by removing the periosteal layer with a diamond cutting burr. Experimental studies on monkeys indicated that early active osteogenesis started from the periosteal layer and that the enchondral layer participated but little in the process.

- 2 Use of continuous irrigation to keep the operative field free from bone dust and blood and to avoid heating of the burr and the bone.

- 3 Avoidance of trauma to the endosteum deep to the margin of the fistula and removal of all loose particles of endosteal bone. The dissecting microscope is an invaluable aid for this step of the technic.

- 4 Meticulous removal of all bone chips from the tympanomeatal flap.

- 5 Taking full advantage of the inhibiting effect of stratified squamous epithelium on osteogenesis. This is accomplished by thinning the flap as much as possible and by contouring the lateral semicircular canal so that the fistula is on the top of a mound rather than at the bottom of a concavity. This assures that the flap will maintain contact with the endosteum at the margin of the fistula.

Based on the observation that, in some patients with an unusually big decibel gain, a fistula response could be readily elicited by pressing an applicator against the pars tensa of the tympanic membrane, the following points of technic were carried out for the purpose of increasing the mobility of the tympanomeatal flap between the tympanic membrane and the fenestra: (1) placing the fistula as close to the tympanic cavity as possible without exposing the facial nerve, (2) placing the tympanomeatal flap under tension while packing is inserted, and (3) preserving the mucosa as much as possible between the fenestra and the facial nerve. (Comment: If future physiologic investigation proves that the tympanomeatal flap is not important in sound conduction to the inner ear, these last three points of technic may be disregarded.)

The observation was made clinically by the authors on patients who had been operated on and in experimental studies on monkeys that the peak of the postoperative serous labyrinthitis seemed to occur

⁶ Shambaugh, G. E., Jr., and Juers, A. L. Surgical Treatment of Otosclerosis. A Preliminary Report on an Improved Technic, *Arch Otolaryng* **43** 549-567 (June) 1946.

when the circulatory congestion of the flap was at its maximum and during the early postoperative period when blood might gravitate to the cochlea. The following measures were adopted with the hope of minimizing these factors: 1. A sea sponge type of packing was used in the cavity postoperatively to decrease this early edema and lessen the tendency for blood and serum to collect under the flap, where it might enter the perilymph space. 2. A small wire frame was applied to the patient's head on the normal side. This forced the patient to lie on the ear operated on or the back of his head, thereby maintaining the cochlea in a position superior to the fenestra. (Comment: While use of a sponge packing is in our opinion an unquestionable improvement in postoperative care, the value of maintaining the cochlea in a position superior to the fenestra in the early postoperative period still awaits proof.)

Altman⁷ describes the histologic observations in a lateral semicircular canal fistula three years after the fistula was presumably accidentally made during a tympanomastoidectomy. He compares his observations with those in 19 other cases reported in the literature. The majority of these fistulas resulted from disease rather than trauma. In summarizing these observations, Altman states that hemorrhage and infection in the area of the fistula and bone chips left behind are the most important factors that promote bony closure of the fistula. A retarding influence on the tendency toward closure is exerted by overlying stratified squamous epithelium. This type of epithelium seems to be particularly resistant to the penetration of infection—much more so than columnar epithelium.

Day⁸ reports his results and observations in a series of 100 consecutive fenestrations. In 4 cases with a bone conduction hearing loss of more than 30 decibels for the speech frequencies, the postoperative hearing by air did not reach the 30 decibel level. Meticulous surgical technic to lessen trauma to the flap and removal of all tiny particles of bone from the flap and fenestral margin tend to minimize the degree of labyrinthitis and decrease the likelihood of bony or fibrous tissue closure. Only a partial mastoidectomy was done, inasmuch as a small cavity heals more rapidly and from an acoustic standpoint there will be less sound distortion than would be present in a larger cavity. There were 10 closures in this series. Six of these were revised, and in 3 good hearing was restored. Including the 3 successful revisions, a 30 decibel or better level of hearing was maintained in 80 cases. In 6 cases the preoperative level of hearing

7 Altman, F. Healing of Fistulas of the Human Labyrinth. Histologic Studies, Arch Otolaryng **43** 409-420 (April) 1946

8 Day, K. M. Appraisal of Fenestration Operation. Report of One Hundred Cases, Arch Otolaryng **44** 547-559 (Nov.) 1946

was between 32 and 35 decibels. There have been seven pregnancies in this series since operation, and no significant ill effect on the hearing in the treated ear has been noted. (Comment: The results obtained by Day represent the highest percentage of successful operations thus far reported in the literature. This is due to a combination of excellent surgical technic and careful selection of cases. It should be noted, however, that not all of the cases reported have been followed for 2 years, so there is still the possibility of more closures in this series.)

Hutchinson⁹ states that he favors the postauricular approach rather than the endaural because of the better exposure provided. He frees the meatal lining down to the tympanic rim before opening the mastoid cortex. The fenestration technic he describes otherwise follows, in general, the modifications advocated by Shambaugh with the exception that the fenestra is enlarged by the use of dental picks. A small amount of epinephrine hydrochloride is added to the saline irrigating solution.

Hall¹⁰ reports his experience with the fenestration operation over a ten year period in over 200 operations. He uses the postaural approach and either intermittent or continuous irrigation, together with adequate magnification with a dissecting microscope. He has obtained improvement in 69 per cent of 118 cases followed eight months or longer, but he does not state the degree of improvement or the final level obtained.

Greenfield¹¹ reports an evaluation of his results of fenestration based on observations of 28 patients who were followed six months or more. In his summary he states that 21 had their hearing restored to the practical serviceable, physiologic level. (Comment: If the speech frequency decibel level is averaged from the published audiograms, there are only 19 cases with an average level of 30 decibels or better. In cases 2 and 14 there is approximately a 32 decibel average level. While these patients probably have serviceable hearing without an aid, the confusion existing in the reporting of fenestration results is illustrated in this paper. Greenfield's report again shows the fallacy and difficulty of trying to evaluate results solely on the basis of whether the final level of hearing is at, above or below one arbitrary line on the audiometric chart.)

9 Hutchinson, C. A. Labyrinthine Fenestration—The Present Position, *J Laryng & Otol* **61** 567-585 (Nov.) 1946

10 Hall, I. S. The Fenestration Operation, *Brit M J* **61** 647-649 (Nov.) 1946

11 Greenfield, S. D. An Evaluation of the Lempert Fenestra Nov-Ovalis Operation in the Treatment of Otosclerosis. Report on Thirty-Six Patients Who Were Selected for This Operation, *Arch Otolaryng* **43** 25-30 (Jan.) 1946

Aubry¹² reviews and compares the technic of European and American surgeons for treatment of otosclerosis. He points out that the so-called surgical dome of the vestibule is merely the anterior region of the ampulla of the lateral semicircular canal. He believes that this more anterior position of the fenestra made by American surgeons may result in more difficulty from vertigo than has been observed by Europeans.

Popper¹³ describes a new fenestration approach through the external auditory canal alone rather than the usual approach through the canal and antrum. The incision is made at the anterior edge of the tragus and enters the external auditory canal at the anterior cartilaginous-osseous junction. Sufficient tympanic plate is removed to expose the tympanic membrane. A small meatal flap is then freed from the posterior and superior canal wall and the epitympanic space entered with a diamond cutting burr. The cavity is kept very small, and the antrum itself is not entered. In creation of the fenestra, Popper follows in general the modifications which have been described by Shambaugh. However, he believes that he places the fenestra farther anteriorly than Lempert's position for the fenestra nov-ovalis. Popper believes that the sacculle may contact the flap in this newer, more anterior position. A specially built headgear incorporating adequate magnification and parallel illumination is essential for carrying out this new technic because the operative cavity is only 15 mm wide at the top and 35 mm deep. (Comment: It seems doubtful that a fenestra can be made more anterior than the Lempert fenestra nov-ovalis position because the perilymph space begins to turn medially and inferiorly at the point of the ampulla. Also, the nerve fibers going to the ampulla of the lateral canal would be cut if the fenestra were placed anterior to Lempert's position. Also, the facial nerve overlies the superior aspect of the vestibule and prohibits more anterior placement of the fenestra.)

Schenck¹⁴ treated 64 patients with clinical otosclerosis by injecting thyroxin into the tympanic cavity as originally advocated by Gray. The treatment failed to effect any alterations in the hearing level which were in excess of the normal variation of the hearing level in otosclerosis.

DEAFNESS DUE TO LYMPHOID HYPERPLASIA OF THE NASOPHARYNX

An effective program for the detection, treatment and follow-up of children with impaired hearing is described by Proctor and

12 Aubry, M. The Surgery of Deafness, *Ann d'oto-laryng* **13** 29-39 (Jan-Feb) 1946

13 Popper, O. Transtympanic Fenestration, *J Laryng & Otol* **61** 441-458 (Aug) 1946

14 Schenck, H. P. Thyroxin Therapy in Otosclerosis, *Arch Otolaryng* **44** 43-50 (July) 1946

Willard¹⁵ These authors believe that 80 or 90 per cent of school children with impaired hearing can be helped by proper therapy. Radiation therapy for lymphoid tissue when indicated has been particularly effective. In addition to the good results obtained in relieving aural conditions caused by excess lymphoid tissue, irradiation also benefited a large percentage of children subject to infections of the upper respiratory tract not infrequently accompanied with bronchial asthma. The use of the nasopharyngeal radium applicator is discussed in detail by Proctor. The majority of the patients were considered well after three or four treatments. There were 5 patients receiving as many as seven treatments. The optimum routine dosage still appears not to be entirely settled.

Boies¹⁶ presents a resume of his experience with radiation treatment of nasopharyngeal lymphoid tissue associated with deafness in 73 patients. Approximately 51 of these obtained satisfactory relief from treatment with a nasopharyngeal applicator. Patients who did not respond were those with a suspected cochlear lesion, an abrupt dip above the 2,048 frequency or with chronic otitis media.

Burnam¹⁷ gives a general review of the facts known about irradiation in terms easily understood by the average clinician. Clinical and experimental observations indicate that radiation is always an injurious agent and never a direct stimulant. However, when radiation is not lethal and when recovery is rapid, an overactivity in growth and other functions may result. The type of applicator now most commonly used for treatment of excess lymphoid tissue in the nasopharynx contains radium salt with a 0.3 mm of monel metal as a filter. This filter is penetrated by both beta and gamma rays. The need for keeping the applicator in a thick-walled lead container when not used in actual therapy is again stressed.

Crowe¹⁸ reviews the clinical and laboratory studies on which the present conception of irradiation therapy in the nasopharynx are based. In addition to the usually generally accepted indications for irradiation therapy, he believes that

even if the hearing is normal, irradiation is indicated as a preventive measure when nasopharyngoscopic examination reveals [hyperplastic lymphoid tissue around the eustachian tube orifice]. It is also called for in all patients with this condition who

15 Proctor, D, and Willard, W. R. Washington County (Maryland) Program for the Prevention of Deafness in Children, Arch Otolaryng **43** 462-472 (May) 1946

16 Boies, L. R. Irradiation of Nasopharyngeal Lymphoid Tissue. An Evaluation, Arch Otolaryng **44** 129-140 (Aug) 1946

17 Burnam, C. F. General Factors in Irradiation Therapy, Ann Otol, Rhin & Laryng **55** 764-778 (Dec) 1946

18 Crowe, S. J. Irradiation of the Nasopharynx, Ann Otol, Rhin & Laryng **55** 779-788 (Dec) 1946

have impaired hearing due to any cause whatever, such as developmental abnormality of the cochlea or auditory nerve, chronic suppuration of the middle ear, or otosclerosis, in order to prevent superimposed or additional impairment from an entirely different cause

An incidental significant observation was that irradiation therapy in some children also relieved asthmatic bronchitis. This may be further evidence that infection in nasopharyngeal lymphoid tissue may be an important factor in some type of respiratory allergy. Large central masses of adenoid tissue should always be removed surgically. It is a general policy now to supplement all surgical adenoidectomies with irradiation. Routine treatment now consists of three treatments of eight and one-half minutes to each side with 50 mg of radium in a monel metal filter applicator at two week intervals. If after thirty or sixty days the desired clinical result has not been obtained, additional treatment may be given.

Fowler¹⁹ presents some of his recent histopathologic and clinical studies of lymphoid tissue in and around the eustachian tube. Microscopic examination of lymphoid tissue taken from the salpingopharyngeal fold of a young aviator one month after one radiation treatment showed that

the germinal centers throughout the specimen have disappeared, and the number of lymphocytes is greatly reduced. Many of those which remain have pyknotic nuclei. The capillaries in the irradiated tissue are prominent. Their endothelium is thickened and their walls are hyalinized. Connective tissue cells are much more prominent than in the control biopsy specimen. The aviator from whom these biopsy specimens were taken sustained marked relief from his aero-otitis and his "scratchy" throat after one radium treatment.

Study of the anatomic material obtained from airmen killed in action indicated that infection is the cause of the presence of lymphoid tissue in the eustachian tube and of any excess about its mouth. The lymphoid tissue was rarely abundant enough to block the tube except at the nasopharyngeal orifice, where it can be readily treated with radiation. However, one specimen is described in which there was a lymphoid mass between the isthmus and middle ear. Fowler points out that thick mucus may be the final block in a tube already narrowed by lymphoid tissue at its orifice. The round cell infiltration produced by infection eventually appeared to push through the ciliated epithelium overlying some of the germinal centers. In some of these areas the ciliated epithelium sloughed away, leaving nonciliated low cuboidal cells.

Of 66 airmen with aerotitis who were treated by radiation and followed, 69 per cent obtained relief and were able to return to regular duty. Fowler discusses the various types of filters used for radium

19 Fowler, E. P., Jr. Irradiation of the Eustachian Tube. An Anatomic, Physical and Clinical Study of a Treatment for Recurrent Otitis Media Applied to Aero-Otitis, *Arch Otolaryng* 43 1-11 (Jan) 1946

therapy in the nasopharynx, and this section of the article, in particular, should be carefully studied by anyone applying radiation to the nasopharynx. He believes that a radium applicator properly used is in most circumstances the most satisfactory source of radiation for excess lymphoid tissue about the orifice of the eustachian tube. A competent radiologist should always be consulted in outlining or changing any treatment routine.

Lieberman²⁰ studied various aspects of aerotitis media as observed in 167 subjects in pressure chamber "flights." Of particular interest is his observation that aerotitis media occurred approximately four times as frequently in those subjects who had marked lymphoid obstruction of the eustachian tube ostium as in those who had grossly relatively little lymphoid tissue. Not all who had otoscopic evidence of aerotitis media had symptoms. In most instances, during descent from "flight" up to 35,000 feet (10,500 meters) the onset of symptoms occurred at between 20,000 and 5,000 feet (6,000 and 1,500 meters).

Because of the observation that movement of the mandible—such as yawning—was more effective than swallowing as a means of equalizing intratympanic and atmospheric pressure during descent from flight, Bierman and Brickman²¹ investigated further the relationship of malocclusion to aerotitis media. Ear block during low pressure chamber descents was found to occur about five times as frequently in persons with malocclusion as in persons with normal occlusion. Positive otoscopic evidence of aerotitis was observed about three times as frequently in the group with malocclusion. The insertion of dental splints during descent in the group with malocclusion reduced significantly the incidence of aerotitis, whereas no change occurred in the normal group. It is thought that in instances of closure of the bite the interference with satisfactory tubal ventilation is caused by the wrinkling of the external pterygoid muscle, sufficient to compress the membranous part of the auditory tube. In addition, the shortening of the span of the tensor palati muscle impairs the efficiency of this muscle in opening the eustachian tube during swallowing.

Haines and Harris²² made a comprehensive clinical study of aerotitis in submariners. The presence of aerotitis was based on objective otoscopic findings rather than subjective after the men had been subjected to 50 pounds (22.7 Kg, 3.4 atmospheres) of pressure in three to ten minutes. Of a total of 6,149 men examined, 26.9 per

20 Lieberman, A. T. Aero-Otitis Media in Pressure Chamber "Flights," *Arch Otolaryng* **43** 500-507 (May) 1946.

21 Bierman, H. R., and Brickman, I. W. The Relationship of Dental Malocclusion to Vacuum-Otitis Media and the Use of Dental Splints During Descent from Altitudes, *Ann Otol, Rhin & Laryng* **55** 5-12 (March) 1946.

22 Haines, H. L., and Harris, J. D. Aerotitis in Submariners, *Ann Otol, Rhin & Laryng* **55** 347-371 (June) 1946.

cent contracted aerotitis media. All men were given a prepressure otolaryngologic examination and an audiometric test. Of those in whom aerotitis developed, one group was selected as a control to be retested later and the rest were divided into five groups. The general results of the various types of treatment are as follows:

- 1 Psychologic treatment, 200 cases, no improvement noted
- 2 Topical shrinkage to eustachian tube, 264 cases, very slight benefit
- 3 Roentgen therapy, discontinued for administrative reasons before results were conclusive
- 4 Dental treatment, 50 cases with evidence of temporomandibular joint dysfunction, 46 relieved (details are given in the next abstract)
- 5 Radium to the nasopharynx, 732 cases effective in about 90 per cent of cases

The control group showed the same incidence of aerotitis on the second pressure test as on the first. The authors conclude that if a man passed the test once he could pass it twice, but if aerotitis developed on the first test then prophylactic treatment was needed.

An attempt was made to determine whether at the initial examination any factors affording a precise method of predicting susceptibility to aerotitis could be discovered. It was found that persons who had very large masses of adenoid tissue over the orifice of the eustachian tube and those who had difficulty in performing the Valsalva maneuver were more susceptible to aerotitis than were those with clear tubal orifices and good ability to inflate the tubes. However, the correlation was not sufficiently precise to be of value in actual selection of candidates for the service.

There was no tendency for changes in weather conditions to alter the daily incidence of aerotitis while this study was carried out. Treatment of acute aerotitis was not found to be of any value, except possibly simple tubal shrinkage.

Very little loss of hearing occurred in ears with a minor degree of damage. However, when the tympanum was filled with blood there was usually some drop in acuity, particularly for the higher tones. The low incidence of associated deafness in submariners in comparison with that associated with aerotitis in airmen may be due partly to the absence of auditory fatigue in submariners. In addition, the airman has his "peak" of aerotitis when he returns to ground level and consults the otologist. On the other hand, the submariner has his "peak" pressure inequality before he returns to the surface.

Haines and Harris conclude the discussion by stating that the most effective prophylactic therapy was either use of radium or correction of temporomandibular dysfunction. They believe that the rationale of either is based essentially on a mechanical alteration.

Kelly and Langheimz²³ studied cases of aerotitis media in the submarine service in relation to disturbances of mandibular function.

²³ Kelly, W. J., and Langheimz, H. W. Dental Treatment for the Prevention of Aerotitis Media, *Ann. Otol., Rhin. & Laryng.* **55** 13-28 (March) 1946.

The cases studied were those of the 50 men receiving dental treatment mentioned by Haines and Harris²². Instead of depending on the static relationship of the jaws, they studied temporomandibular articulation in the open and closed positions as well as the general occlusion of the teeth. Objective otoscopic observations were used for diagnostic evaluation both before and after dental treatment because positive otoscopic evidence of aerotitis was not always accompanied with subjective symptoms. Their dental technic for diagnosing disturbances of bite and methods of correction are described in detail.

The patients selected for treatment consisted of 50 men with aerotitis media following exposure to pressure who had, in addition, interference in mandibular function as determined by the described dental technic. Two control groups consisted of (a) an untreated group without aerotitis media on the first chamber run, and (b) an untreated group with aerotitis media on the first chamber run. Of the 50 treated patients, 46 were able to undergo a pressure chamber run with no resulting aerotitis. The two untreated groups remained unchanged. In only 3 of the 46 successfully treated patients were splints applied. Kelly and Langheinze feel that the poor results obtained by some previous workers can be explained by the too frequent use of splints to open the bite when the dysfunction was actually due to other mechanical disturbances, which in some instances would be aggravated by splints. Twenty of the group treated by dental means had enormous adenoids that covered the ostia of the tubes. Radium therapy was successfully used in 3 of the 4 cases in which success was not attained by dental means. Two of the 46 men relieved by dental treatment had previously had radium therapy, without success. The authors believe that in some instances of dysfunction of the temporomandibular articulation a disturbance of muscular balance in the vicinity of the eustachian tube may interfere with lymphatic drainage from the middle ear and eustachian tube area. Several authoritative references are cited in support of this concept.

DEAFNESS DUE TO TRAUMA

To test a patient's susceptibility to auditory fatigue, Macfarlan²⁴ exposes the ear to the 1,024 or 2,048 frequency at an intensity of 25 decibels above threshold for three minutes. The threshold is then again determined and the difference between this level and the one obtained before the three minute exposure represents the fatigue. Macfarlan believes that the significance of the test is that persons showing a tendency toward fatigue should be transferred away from environments with excessive noise.

²⁴ Macfarlan, D. Fatigue Test and Its Significance, *Arch Otolaryng* **44** 334-336 (Sept.) 1946.

Stewart and Barrow²⁵ studied the effect of gunfire noise on 100 gunnery instructors. Routine audiograms and examinations were made before exposure to gunfire, and no tinnitus or audiometric evidence of deafness was noted. After exposure to gunfire 50 per cent of the men complained of tinnitus. If further exposure was avoided after the onset of tinnitus, there usually was recovery, but if exposure was continued the tinnitus became persistent. In every patient with tinnitus there was a loss of hearing in the higher frequencies (2,048 to 11,584 cycles). There was a pronounced individual variability in susceptibility to acoustic trauma. Maximum recovery occurred by six months after cessation of exposure to noise. Composite audiograms after prolonged exposure showed the maximum dip at the 4,096 frequency.

Hendricks²⁶ observations on acoustic trauma coincide in general with those of Stewart and Barrow. The "peak crash" or pitch of the noise produced by a single .50 caliber machine gun has been estimated to exceed 10,000 cycles per second and the intensity of the noise to exceed 170 decibels. Most of the men stated that tinnitus ordinarily was present the evening after a day on the ranges but had disappeared by the following morning. Those with impaired hearing noted it constantly, although it was temporarily worse for an hour or two after a day's work. The left ear was often involved more severely, presumably because it was usually closer to the guns. The damage tended to be more permanent for the higher frequencies whereas there was usually some recovery for the lower frequencies after rest. The improvement after rest was variable. Although a few men showed considerable recovery, others showed very little.

Davis and co-workers²⁷ summarize their observations on acoustic trauma in the ears of 15 young men who were exposed to pure tones and noise at intensities of 110 to 130 decibels for periods of one to sixty-four minutes. Temporary impairment of hearing was regularly produced, but there was no evidence of cumulative injurious effects. No significant elevation of auditory threshold was produced for tones of frequency lower than the exposure tone. The greatest loss occurred at a frequency about half an octave above the exposure tone. With brief exposures the loss may be confined to the two octaves above, but with the longer exposures the hearing loss may be rather extensive for all tones above the exposure frequency. Recovery from a 60 decibel loss may require four to five days. The recovery tends to be slowest for tones in the vicinity of 4,000 cycles. In spite of elevations of

25 Stewart, J. V., and Barrow, D. W. Concussion Deafness, *Arch Otolaryng* **44** 274-279 (Sept.) 1946

26 Hendricks, J. E. War Deafness in Gunnery Instructors, *Ann Otol, Rhin & Laryng* **55** 68-80 (March) 1946

27 Davis, H., Morgan, C. T., Hawkins, J. E., Galambos, R., and Smith, F. W. Temporary Deafness Following Exposure to Loud Tones and Noise. *Laryngoscope* **66** 19-21 (Jan.) 1946

threshold of 50 or 60 decibels, there may be little or no loudness loss for sounds at 100 decibel loudness level. The audiogram alone is not an adequate measure of the impairment of auditory function.

Exposure to a pure tone that causes a hearing loss that is restricted to a relatively narrow range of frequencies may cause very severe distortion of pitch perception (diplacusis). The major displacements of pitch are always upward. Exposure to a band spectrum noise (like airplane noise), which causes a widespread hearing loss that is usually severest in the high frequency range, is relatively ineffective in producing diplacusis.

Prolonged exposure to an intense 500 cycle tone or to noise of wide frequency spectrum causes severe articulation loss at a low (40 decibel) loudness level but only moderate loss at a high (100 decibel) level. The articulation loss for loud speech following exposure to the 500 cycle tone tends to be the greater of the two, even though the average hearing loss measured by audiogram is less, probably because of the greater diplacusis produced by the exposure to the pure tone. Exposure to an intense 1,000 cycle tone may or may not produce a measurable articulation loss for loud speech, and exposures to 2,000 and 4,000 cycle tones cause but little articulation loss, even at the 40 decibel loudness level, for speech heard through a standard Army headset.

PSYCHOGENIC DEAFNESS

Truex²⁸ reports his experience with psychogenic deafness at Deshon General Hospital. No single fact or test result was diagnostic other than cure by psychiatric methods. However, the following were clues suggesting the diagnosis:

- 1 Signs of definite agitation and anxiety during interviews
- 2 Inconsistencies in the clinical history
- 3 Severe loss without reasonable cause
- 4 Negative physical findings to account for the deafness
- 5 Various tests of hearing acuity indicating a functional element
 - a Severe bilateral or unilateral hearing loss, regardless of cause, particularly when there was no response to bone conduction testing
 - b Unusual variations in repeated tests
 - c Large discrepancy between speech reception and pure tone average for the better ear
 - d An unexpectedly large or small gain from the use of a hearing aid
 - e The Doerfler-Stewart test, done by increasing a background of masking noise to a patient who is listening to speech at 5 decibels louder than threshold. Whereas the normal listener continues to perceive speech until the level of noise is 10 to 25 decibels more intense than speech, the patient with a functional element ceases to hear speech before the masking intensity reaches that of the speech.

28 Truex, E. H., Jr. Psychogenic Deafness, Connecticut M. J. **10** 907-915 (Nov.) 1946

Appropriate psychiatric investigation and treatment resulted in symptomatic cure in 69 per cent of cases, improvement in 20 per cent and no change in 11 per cent

Martin²⁹ reports his experience in detecting and treating psychogenic deafness at Hoff General Hospital, particularly with respect to the use of pentothal sodium® narcosis (narcosynthesis) Narcosynthesis was used only on selected patients as an adjunct to the usual psychologic methods Of the patients studied under pentothal sodium® narcosis, 12 per cent were found to have psychogenic deafness A high percentage of these had good hearing restored after correction of the psychogenic involvement (Comment The relative frequency of psychogenic deafness in military personnel is in sharp contrast to its rarity among civilians Nevertheless, it does exist in the civilian population to a greater degree than hitherto suspected The possibility of a psychogenic hearing loss should be kept in mind in patients with a perceptive defect that fluctuates in degree and with a discrepancy between the loss for pure tone and the loss for speech)

MÉNIÈRE'S SYNDROME

Atkinson³⁰ reviews the present status of knowledge of the pathophysiology of Ménière's syndrome and believes that the basic disturbance is one of increased production of endolymph resulting from increased capillary permeability A number of authors have described various etiologic factors, such as vasospasm, histamine sensitivity, allergy, avitaminosis C and toxic labyrinthitis due to focal infection In Atkinson's opinion, probably all these various factors produce Ménière's syndrome by the mechanism of increasing capillary permeability Hence he feels that treatment with histamine or nicotinic acid in properly selected groups is more fundamental than combating the dysfunction through increasing potassium or decreasing fluid intake

Day³¹ reports the results of his labyrinthotomy operation in 21 cases of Meniere's syndrome Nineteen patients with unilateral involvement have all been rehabilitated and are completely free from vertigo and the low-pitched roaring tinnitus (between 100 and 300 cycles) However, the high-pitched tinnitus continues and may be more pronounced Two patients had bilateral involvement and continue to have some symptoms from the side not operated on Day cannot report good results in the preservation of hearing except in 1 case in which a 70

29 Martin, N A Psychogenic Deafness, *Ann Otol, Rhin & Laryng* **55** 81-90 (March) 1946

30 Atkinson, M Meniere's Syndrome The Basic Fault? *Arch Otolaryng* **44** 385-391 (Oct) 1946

31 Day, K M Hydrops of Labyrinth (Meniere's Disease) Diagnosis—Results of Labyrinth Surgery, *Laryngoscope* **56** 33-42 (Feb) 1946

decibel level before operation improved to within normal limits after operation and remained at this level during four years of observation. Day believes that labyrinthotomy is preferable to section of the eighth nerve in cases of Ménière's syndrome which do not respond to a reasonable period of medical treatment.

McLaurin³² reports his experience with the use of histamine azo-protein (hapamine®) in treating 40 patients with vertigo in the form of pure Ménière's disease or in the incomplete form. A few patients had side reactions to the injections. With a few exceptions the results were good. Fifteen of the patients have been followed for more than a year.

Lindsay³³ reports the histologic changes in 2 additional cases of unilateral hydrops of the endolymphatic labyrinth. In both instances there was dilatation of the cochlear duct in the involved ear. In 1 ear of the first patient the cochlear duct was dilated to the point of obliterating the scala vestibuli and Reissner's membrane was expanded into the vestibule. There was complete loss of hearing in this instance, but no record of the presence or absence of vertigo was available. In the other patient there was considerable high tone loss for both ears and, in addition, some low tone loss for the involved ear. There was a history of vertigo. The cochlear duct was moderately dilated, and the wall of the saccule showed a rupture which was presumably old. All ears showed some degenerative changes in ganglion cells in the basal coil of the cochlea. Histologic observations up to the present have given no definite indication of the cause of hydrops. The evidence to date does not support the hypothesis of disturbed resorption of endolymph. The fluctuations in threshold of hearing, the sensation of blockage and the severity of the low-pitched noises in the ear can probably be related to changes in endolymphatic pressure. The great variety of histologic changes found in the vestibular apparatus seems to give a partial explanation for the inconsistency in the occurrence of vestibular symptoms.

Wright³⁴ believes that the cochlear lesions of Meniere's disease precede the vestibular in the majority of instances. Tinnitus is an early symptom. The deafness is usually unilateral, and diplacusis is frequently noted.

32 McLaurin, J. W. Desensitization by Histamine (Histamine Azo-protein) in Vertigo, Periodic Headaches and Vasomotor Rhinitis. Review of the Literature and Report of One Hundred and Two Personal Cases, *Laryngoscope* **56** 253-281 (June) 1946.

33 Lindsay, J. R. Labyrinthine Dropsy, *Laryngoscope* **56** 325-341 (July) 1946.

34 Wright, A. J. Cochlear Deafness, *Proc Roy Soc Med* **39** 265-269 (March) 1946.

Athens³⁵ reports on 30 patients with low basal metabolism who were subject to recurring attacks of true vertigo, fatigue and low blood pressure but with little or no deafness. Treatment with desiccated thyroid was satisfactory. The similarity between these cases and true cases of Ménière's symptom complex is discussed, particularly with reference to the water retention in thyroid deficiency and the endolymphatic hydrops in Ménière's disease.

MISCELLANEOUS CONTRIBUTIONS ON CAUSES AND TREATMENT OF DEAFNESS AND IMPAIRED HEARING

Hopkins³⁶ investigated the relationship of antepartum German measles to congenital defects in children at the Clarke School for the Deaf. In 116 cases of deafness there were 10 instances in which the mother had had rubella during the pregnancy.

A new treatment for impaired hearing, consisting of administration of a combination of amino acids and vitamins is described³⁷. In 25 of 78 patients treated, improvements of 10 decibels or more were reported. The diagnosis of the cases treated is not given. (Comment: Since no diagnostic data are given by the authors in their article, the reviewers wonder whether in cases such as are reported in charts I and VII the hearing loss may have been due to a secretory otitis, which, in some instances, is spontaneously reversible. We have tried this treatment in a series of about 35 cases of perceptive and conductive deafness and have obtained no audiometric or subjective improvement in hearing in a single case. Acute lesions such as secretory otitis or other readily reversible conditions were not included. There was occasionally, however, an improvement in the feeling of well-being and a few instances of improvement in tinnitus. A few patients thought that their tinnitus was worse.)

In 1,000 consecutive cases of deafness studied at the Aural Rehabilitation Service at the United States Naval Hospital in Philadelphia³⁸ it was concluded that in 14 the deafness (a loss of at least 30 decibels in the better ear for the 256 to 2,048 frequencies) was due solely or predominantly to drug therapy. Quinine was apparently the causative agent in 12 cases and salicylates in 2. Tinnitus was an early symptom. The toxic effect is presumably on the ganglion cells. There is also a question of decrease in pressure of the endolymph.

35 Athens, A. G. Vertigo in Hypothyroidism, *Minnesota Med* **29** 562-567 (June) 1946.

36 Hopkins, L. A. Congenital Deafness and Other Defects Following German Measles in the Mother, *Am J Dis Child* **72** 377-381 (Oct.) 1946.

37 Hirschfeld, H., Jacobson, M., and Jellinek, A. New Treatment for Hearing Disorders, *Arch Otolaryng* **44** 686-700 (Dec.) 1946.

38 Howard, J. C., Jr. Auditory Impairment Caused by Drugs, *U. S. Nav M Bull* **46** 387-391 (March) 1946.

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OTOSCLEROSIS THEORY OF ITS ORIGIN AND DEVELOPMENT

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AND

DOROTHY WOLFF, Ph D

NEW YORK

IN THE May 1945 issue of the ARCHIVES OF OTOLARYNGOLOGY we published a report of our histologic study of the incus and the head and neck of the malleus. These ossicles were removed during the performance of the fenestra nov-ovalis operation in 115 cases of ankylosis of the stapedial footplate caused by a proliferating otosclerotic lesion in the region of the oval window. Attention was called to the fact that a single case of otosclerosis involving the malleus and the incus, as proved in microscopic sections, had been reported and illustrated in the literature¹. The object of our study was to determine how frequently otosclerosis involves the incus and the malleus in the presence of an otosclerotic lesion within the otic capsule.

We reported that in the series of ossicles examined, no typical circumscribed focus of otosclerosis was observed. No pathologic area clearly demarcated from adjacent normal bone was found. No area such as has been seen in the region of the oval window or elsewhere in the otic capsule could be demonstrated in the two temporal bones from the 2 patients who died from irrelevant causes after undergoing the fenestration operation for clinical otosclerosis. We did, however, observe numerous pathologic changes in the joints, in the marrow spaces and in the bone of these ossicles and particularly in the blood vessels thereof. In fact, completely normal ossicles were found in only 5 of the 115 cases examined.

A histologic study of a second series of ossicles removed from 100 patients whose labyrinths were being fenestrated for clinical otosclerosis is herewith presented. In this study the incus, the head and neck of the malleus and occasionally the head and crura of the stapes were included. As in the preceding series, no typical circumscribed focus of otosclerosis was found. No clearly demarcated pathologic area comparable to that occurring in the otic capsule of the otosclerotic

From the Lempert Institute of Otology and the Lempert Research Foundation, Inc.

¹ Covell, W. P. The Ossicles in Otosclerosis. *Acta otolaryng* 28: 263, 1940.

patient could be demonstrated. As in the preceding series, numerous pathologic changes were observed, with completely normal ossicles being found in only 4 cases. Again pathologic changes were found in the joints, the bony tissue and the marrow spaces of the ossicles and particularly in the blood vessels.

COMMENT

Since the pathologic changes observed in the ossicles removed in vivo from patients suffering from clinical otosclerosis were identical with those observed in the ossicles of postmortem material wherein the lesion of otosclerosis was observed in the otic capsule (see figs 29 to 32), we felt that the lesions occurring in the ossicles, though not circumscribed, were part of the otosclerotic process observed in the otic capsule. We believe that the reason the lesions in the ossicles are not circumscribed by healthy bone, whereas in the otic capsule they are, is that the number of blood vessels normally feeding the ossicles is limited as compared with the much richer blood supply normally nourishing the otic capsule. The ossicles receive their blood supply from one or at most two sources,² and the otic capsule from six sources³ (perhaps more).

One of the outstanding observations made in the histologic study of these two series of ossicles was that the blood vessels constantly show pathologic involvement and that this is similar to the pathologic involvement of the blood vessels of otosclerotic foci observed within the otic capsule. Since these ossicles were always removed in vivo and did not undergo postmortem changes, we felt that an unusual, heretofore unobtainable, opportunity for careful study of the blood vessels and their contents was presented in this second series of 100 ossicles. Furthermore, we felt that by carefully observing the pathologic changes in the blood vessels and correlating them with the pathologic changes in the bony structure of the ossicles we could perhaps determine whether the vascular changes were not most likely the forerunners of, and responsible for, the pathologic changes in the bony structure known as otosclerosis.

VASCULAR ANATOMY OF THE OSSICLES HISTOLOGICALLY TRACED

In a study of the vascular supply of the normal ossicles attention must be given to the fact that we are dealing with the smallest bones of the body. The caliber of the vessels concerned is therefore a matter of relativity. Vessels ramifying through these bones and

² Nabeya, D. The Blood-Vessels of the Middle Ear, in Relation to the Development of the Small Ear-Bones and Their Muscles, *Folia Anat japon* 1 243, 1922-1923.

³ Bast, T. H. The Blood Supply of the Otic Capsule, *Anat Rec* 48 141 1931.

establishing haversian systems are of necessity only of the caliber of the arterioles or even of the arteriolar capillaries found elsewhere in the body. Since there is but little need for muscular walls, muscle cells are but seldom seen in these minute vessels. Most of the vessels seem to depend solely on an endothelial wall. Interestingly enough the long axes of the nuclei of the endothelial cells appear to lie not only longitudinally with the course of the vessel but also circularly. This anatomic arrangement suggests a functional response, if not to neural stimulation, then to chemical stimulation. The possibility that pericytes are present as an aid to contraction must also be considered.

Some of the blood vessels ramifying through these bones take origin in their own local marrow spaces. These, as previously described, occur in the body of the incus and in the head of the malleus. The descending vessel of the descending process of the incus has been traced in many ossicles to this source. But these marrow spaces must of course maintain some connection with the vascular supply of the rest of the body. Accordingly, each ossicle has a nutrient artery coming as a branch of the middle meningeal artery.

The nutrient vessel of the incus enters the ossicle on the anterior surface just below the articular surface. The nutrient vessel of the malleus enters the neck of that ossicle.

Additional vessels may occasionally be observed passing from the mucosa to the bone or vice versa. It is difficult to know in which direction the vascular flow may be *in vivo* in these minute channels since there is no observable change in caliber. One such vessel was frequently observed by us to cross from the mucosa to the bone or vice versa on the superior surface of the malleus. Another was noted at the lower extremity of the descending process of the incus. In several instances the descending vessel of the descending process of the incus was observed to travel completely through the bone and emerge in the connective tissue of the submucosa at the lower extremity. Whether this descending arteriolar capillary ever entered its accompanying vein and allowed its contents thus to return to the marrow space is uncertain.

As stated, the study of the two series of ossicles routinely showed involvement of the blood vessels. An especial effort was therefore made to demonstrate their condition in the second series of ossicles. To this end the vessels in the marrow spaces were examined, the vessels in the descending process of the incus were studied, and those in the short process of the incus were studied, as were also those in the head and neck of the malleus. Those in the neck and the crura of the stapes were also examined when these were present. The vessels in the mucosa covering the ossicles were observed when that membrane was intact.

Within a haversian canal the venule accompanying the arteriole or arteriolar capillary may be three to five times the caliber of the arteriole. This is well illustrated in the apparently normal vessels of the descending process of the incus seen in figure 1.



Fig 1—Normal arteriole and venule in the descending process of the incus. The venule may be three to five times the caliber of the arteriole. Numerous polymorphonuclear cells are present in the venule. W F, and adult, specimen 11.

THEORY OF ORIGIN AND PROGRESSIVE DEVELOPMENT OF OTOSCLEROSIS

After carefully studying and analyzing the pathologic changes in the second series of 100 ossicles, we shall present those changes which appear to us to be various stages of the otosclerotic processes in what

we believe to be the order in which the pathogenesis of otosclerosis most likely occurs

We shall first consider the contents of the blood vessels, then the walls of these vessels within the ossicles, and finally the gradual and insidious changes in the bone itself, which appear to arise from the pathologic conditions of the blood vessels



Fig 2—The arrow indicates the clear globules present within a vessel In the haversian canal in the upper left field, two globules have emerged from the vessel and are becoming distorted in shape as from the absorption of a gas

Changes in Vascular Contents—Congestion and stasis⁴ have long been observed within the vessels in otosclerosis In the present study

4 Wittmaack, K Die Ursache der Otoklerose Ein Vorschlag zur ursachlichen Behandlung, Arch f Ohren-, Nasen- u Kehlhopfh 129 150, 1931

we desired to observe, if possible, the contents of the congested vessels and to study the preliminary stages of the production of the congestion and stasis

1 Clear globules A quite unanticipated finding was that of clear globules commonly occurring within the lumen of the vessels. In 23 per cent of the cases these were observed in areas other than the marrow spaces. Vessels in the marrow spaces were not included in the count, because it was felt that in such vessels the globules might merely represent fat that was being transferred to or from the marrow

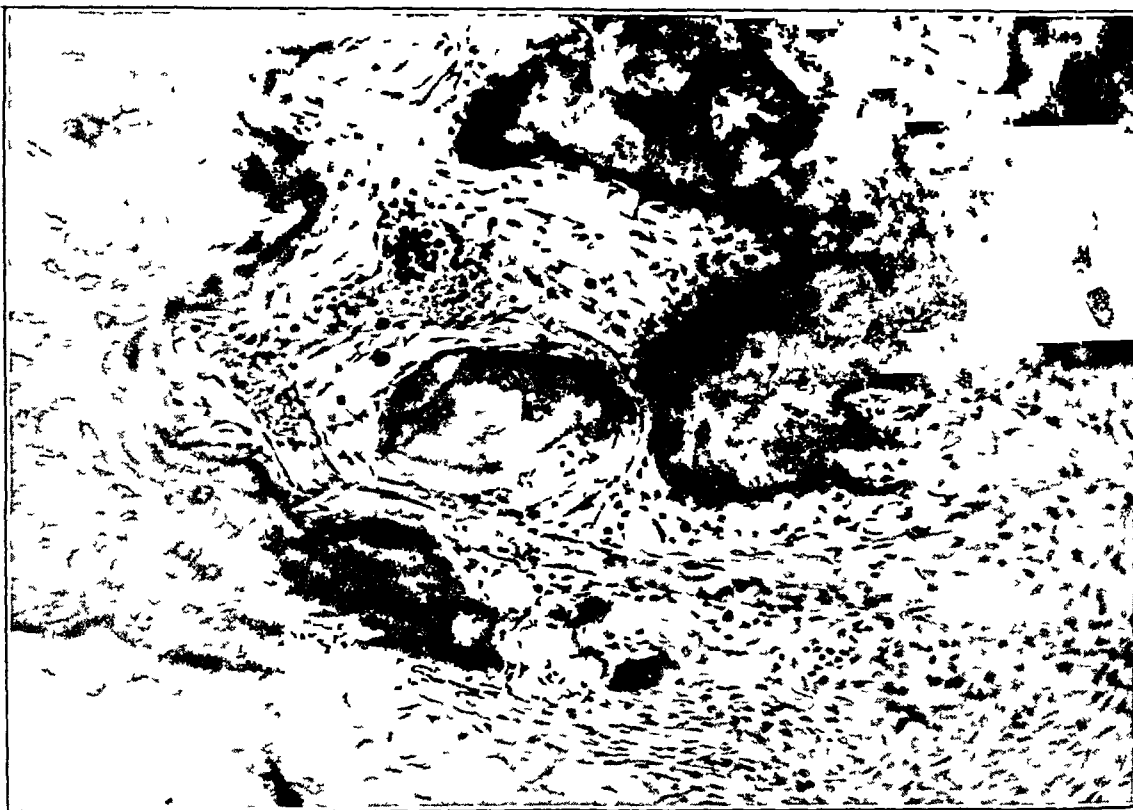


Fig 3—An island of bone is being formed in the process of pathologic decalcification. Note the evidence of congestion and stasis. Clear globules may be seen within the vessel and emerging through the wall. W. M., aged 28, specimen 1585

space. The globules sometimes were so abundant as to fill more or less completely portions of the vessels, sometimes they were aligned along the vessel walls. Figure 2 shows these globules within vessels in the upper center field. In figure 3 the globules are seen in the act of emerging through the vessel wall and escaping into the surrounding tissue. Once having escaped, they do not maintain their globular shape but become distorted. Their appearance is that of a balloon absorbing gas. Figures 13 and 18 illustrate, in their center fields, the distending type of globule.

Such globules were photographed and reproduced without comment in our previous paper concerning ossicles, in figures 16 C and 18. Examination of microscopic sections of ossicles from patients with clinically diagnosed otosclerosis of the petrosa, as well as of otosclerotic centers from patients without clinically diagnosed oto-



Fig 4—Sludged blood in a tortuous vessel in the neck of the malleus W M, aged 24, no 2272

sclerosis but with the typical microscopic lesion, revealed that clear globules are numerous within the vessels in the involved area. A question arises as to the significance of these globules. Do they represent the beginning of edema in the tissue or are they a part of the process of saponification and decalcification?

2 Accumulating fragmented red blood cells These were observed within the lumens of vessels in 27 per cent of the cases They occurred in both arterioles and venules They were often seen in areas of excessive constriction and hypertrophy of endothelial cells But since they were also seen in widely patent veins, it seems likely that a chemi-



Fig 5—Early periodic constrictions of a vessel in the descending process of the incus Note the two clear spaces to the right of the vessel W F, aged 52, no 543

cal condition caused their disintegration This might have been lack of oxygen and accumulation of carbon dioxide They were often found in the neighborhood of numerous polymorphonuclear cells

3 Sludge Clusters of misshapen red blood cells were observed agglutinated to each other, each aggregation separated from the succeed-

ing one by a clear space. Occasionally the clusters were agglutinated to the vessel wall. More often they were free in the lumen. The appearance was strikingly like that of the sludged blood seen in movies of living human and animal tissues. This seemed to be a "still" picture of the same process. It was observed in 21 per cent of the cases. Only 3 of



Fig 6—Early varicosities of the vein of the descending process of the incus. W F, aged 20, no 1269

these cases fell into the group in which the globules were seen within the lumen. Sludged blood is illustrated in figure 4.

4. Accumulating polymorphonuclear leukocytes. These cells were predominantly the mature form of polymorphonuclear neutrophils, although band forms occurred. They were observed in 40 per cent of

the ossicles Round cells were also observed, but not nearly so often Considering the chronicity of the disease the presence of polymorphonuclear cells is somewhat surprising It is possible that they were called forth as a result of the inflammation arising from the localized operative procedure In figure 1 they are seen in an otherwise normal vessel in the descending process of the incus

Changes in the Vessel Walls—1 Constriction Some vessels appeared slightly constricted at regular intervals Where no actual pathologic change of either the wall or the surrounding tissue was



Fig 7—Note the changing caliber of the arteriole as it crosses the marrow cavity In the upper right corner of the field it is expanded In the center field it is constricted, allowing the passage of only a row of red blood corpuscles In the lower left field no lumen is apparent W F, aged 52, no 1178

noted, the constriction may have represented the normal rhythmic action caught by the surgeon at the time of removal of the ossicles

(a) Constriction of venule Figure 5 illustrates periodic constriction of the walls of a venule of the descending process of the incus Evidence of incipient pathologic change may be observed in the two elongated clear areas to the right in the vessel These represent either the first evidence of edema or gas absorbed by certain clear globules as described in foregoing paragraphs In fact, they may prove to be the microscopic picture of both of these conditions

More extensive constriction of a venule was found to lead to dilation of the vessel above and below the constricted area. Such a condition may be observed in figure 6 where early varicosities appear in the vein of the descending process of the incus of a 20 year old girl. The con-



Fig 8—A descending vessel of the descending process of the incus, reduced to a mere strand by complete constriction. Note the red blood cells in the patent portion in the upper right field. Three Howship's lacunas are seen in the bone bordering the vascular channel in the lower center field. W. M., aged 22, no 1333.

comitant pathologic stasis, long recognized as a part of the microscopic otosclerotic picture, is here apparent.

(b) Constriction of arteriole. In figure 7 the constriction of an arteriole as it passes through a marrow space is clearly illustrated.

Complete constriction of an arteriole is again illustrated in figure 8, here occurring in the descending vessel of the descending process of the incus

In regard to the matter of constriction of a vessel one must take into account the length of time the constriction lasts. In our study it

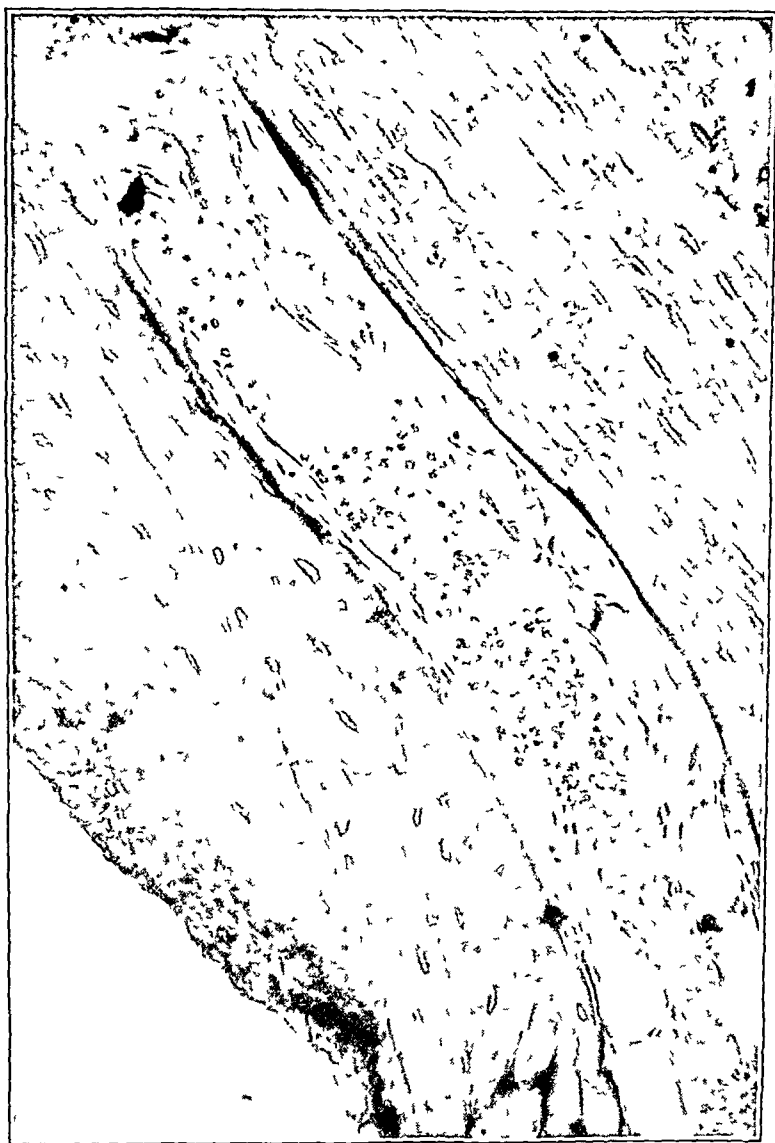


Fig 9—Periodic constriction and partial obliteration of the descending arteriole of the descending process of the incus W F, aged 45, no 1308

is impossible to observe the time factor, but the consequences of prolonged constriction may be seen (Compare figure 24 with figure 8 to realize the nature of the pathologic changes occurring throughout this ossicle as a result of the pathologic changes occurring in the individual vessels)

Periodic constriction of long standing is well shown in figure 9. Here in two of the constricted areas obliteration of the vessel is occurring. Of course, one must study serial sections to be sure of such an interpretation of this condition.

2. Tortuosity. In the preceding communication on ossicles we mentioned tortuosity of vessels as being most conspicuous among the



Fig. 10—The descending vessel of the descending process of the incus, showing intermittent hypertrophy of endothelial cells. Note the pull of the vessel toward the hypertrophied cells, thus initiating tortuosity. W. F., aged 34, no. 549.

early vascular changes. In the present study we have attempted to find the incipient stages in the changes of the walls of the vessels leading to the production of tortuosity. In figure 10 we illustrate a very early stage in the development of tortuosity.

Hypertrophy of endothelial cells is obviously causing this condition. The hypertrophy occurs intermittently on one wall and in the intervening region on the opposite wall. The result is that a torque or pull of the vessel wall occurs toward the side of the hypertrophied cells, and tortuosity is produced. The possibility that pericytes are present on these nonmuscular walls has been mentioned. In figure 10 two apparently multinucleate structures appear on the right wall of the vessel. We are inclined to believe these are contractile processes of a pericyte coming into view and not multinucleate giant cells or osteo-

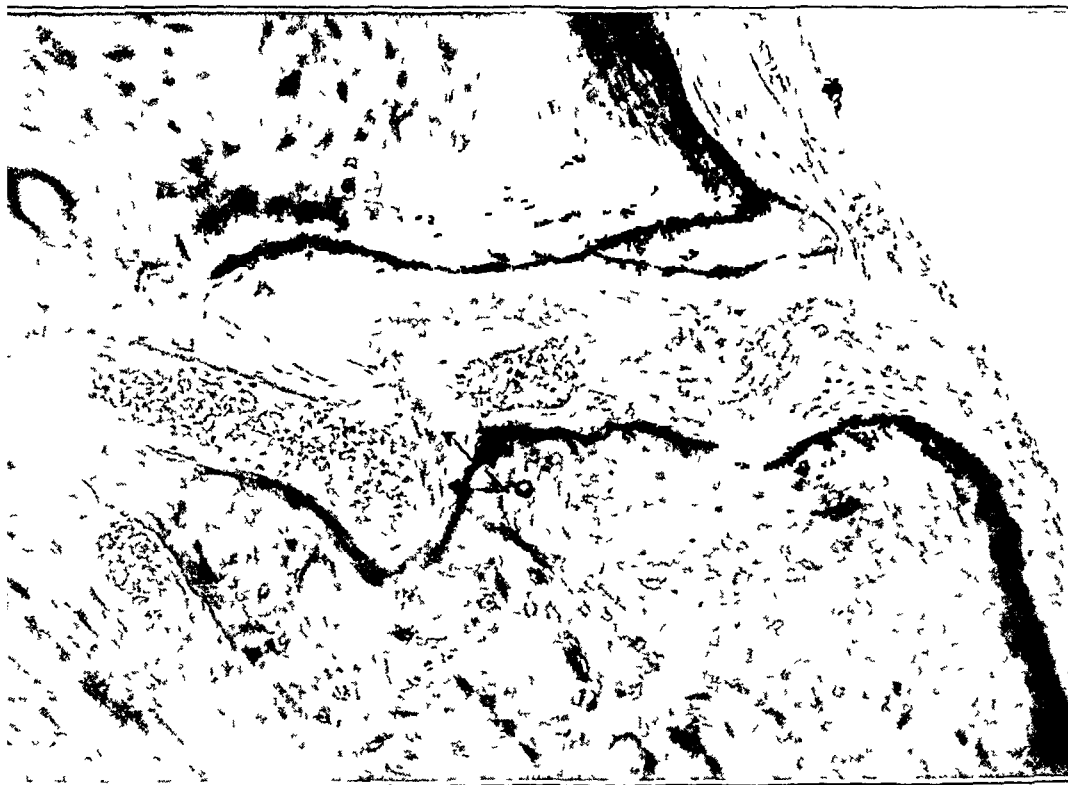


Fig 11—Hypertrophy of the endothelial cells passing into the head of the malleus. Note the tortuosity of the vessel. Fragmentation of red blood cells is present. W F, aged 52, no 1178.

clasts—which, incidentally, have been conspicuously absent in the sum total of these 100 ossicles.

In figure 11 one sees hypertrophy of endothelial cells producing marked tortuosity of the vessel and obliteration of the lumen, this last process resulting in obliteration of a part of the vessel itself.

The ultimate extent to which tortuosity of vessels can progress is illustrated in figure 12, a vessel in the descending process of the incus. Tortuosity of venous walls develops mostly from varicosities such as were described and illustrated in figure 6.

3 Periarteritis This condition was described in our previous paper as occurring in 24 per cent of the cases. The condition might also be described as perivascular fibrosis, since it may arise around the venules as well as around the arterioles. This type of pathologic change occurred in the marrow spaces in 32 per cent of the cases and in the descending vessel of the descending process of the incus in 27 per cent of the cases. Only in 9 of the cases was this kind of pathologic condition exhibited in

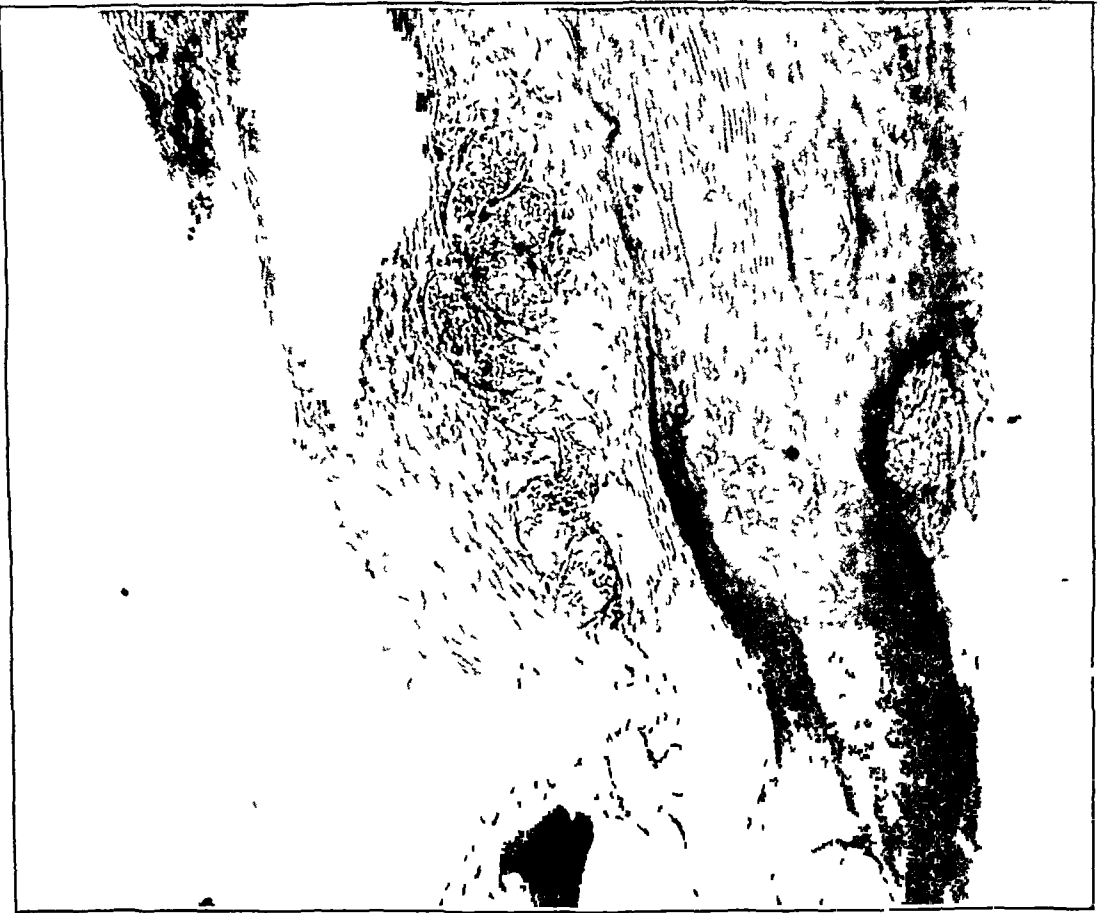


Fig 12—A tortuous vessel in the descending process of the incus W M, aged 63, no 2096

both of these regions. Figure 13 shows this lesion in the descending process of the incus.

4 Endarteritis Obliterative endarteritis is well illustrated in figure 14. In three different areas in this field proliferation of the cells of the inner wall of these minute vessels may be observed. In the upper right the lumen of the vessel is only partially obliterated. In the middle and lower fields the lumen of the vessel is completely occluded. The ultimate consequences of this type of pathologic change are seen in figure 23.

Pathologic Changes of Bone—1 Blue mantles Blue mantles have long been described as a part of the microscopic picture of otosclerosis (fig 15) The subject was discussed in our previous communi-



FIG 13—Perivascular fibrosis around the descending vessels of the descending process of the incus. Note the tortuosity, congestion, stasis and presence of clear globules. These are within the vessels, and one greatly dilated globule is in the surrounding tissue (center field). W F, aged 54, no 1233

cation. The general microscopic appearance of bone may be altered by the contents of the blood stream. Blue mantles are the walls of haversian canals which take an intensely blue dye with the hematoxylin

Blue mantles may occur in bone that is not otosclerotic, but they are always conspicuous in bone that is from patients with otosclerosis. They may, in a sense, be considered as chemical indicators of the type of calcium that has most recently been deposited along a particular blood



Fig 14—Detail showing obliterative arteritis. The vessel in the upper right corner shows partial obliteration due to hypertrophy of the endothelium. Periarterial fibrosis is also present. In the center and in the lower left corner complete obliteration of small vessels has occurred. Numerous lacunae devoid of bone cells give evidence of necrosis. W F, aged 36, no 12.

vessel. The spread of fluids emerging from the blood stream may be traced by the chemical reaction occurring in the bone along the canaliculi immediately adjacent to a haversian canal. In fact, there is a time in the

course of pathologic changes of bone when the row of lacunas lying immediately parallel to a haversian canal appear under the microscope like insects walking along a stick. At a later time the canaliculi on the other side of the lacunas will spread the devastating fluid to more distant lacunas. As this occurs, marked irregularity of staining is evident



Fig 15—Blue mantles along the vascular channels of the incus. They are more conspicuous in ossicles from otosclerotic patients. W F, aged 28, no 2087

(fig 16) The colors with hematoxylin and eosin staining may range in the same section from a grayish pink to a dark purplish blue in the bone itself. Areas of pale-staining bone may lie adjacent to areas showing excessive affinity for the dye or they may be adjacent to areas

giving a perfectly normal staining reaction. The more deeply staining bone may present a "seedy" or "peppery" appearance (fig 17). What are the underlying causes of these varying hues? Selective affinity for dyes is known to be related to the chemical content of tissues. Vascular



Fig 16—Note the irregular staining reaction of the bone in this incus, particularly along the superior border. In the lighter areas many lacunas are devoid of bone cells, indicating necrosis. In the marrow space venous stasis is present with periarterial fibrosis. Obliterative arteritis also exists. The vessel in the Haversian canal running diagonally at the bottom of the picture no longer possesses a lumen. See figure 22 W F, a woman aged 50, with a clinical diagnosis of otosclerosis, no 1335 A.

changes appear to initiate these chemical reactions and to be the source of early disintegrative changes in the bone. The consideration of the

microchemical changes that occur within the vessels and in the tissue fluids, producing the dissolution of the normal structure of the bone, is beyond the scope of this paper. We here present the microscopic changes which we now believe to be a part of the otosclerotic process.

2 Hypervascularity. Vessels traversing the bone in these specimens are frequently supernumerary. In the sections the bone may appear to be



Fig 17—Pathologic bone showing a "seedy" appearance due to the enlargement of lacunas as the decalcifying tissue fluids spread from the haversian canals. W. M., aged 38, no. 548.

riddled with perforations. Common sites for such a condition are the neck of the malleus and the bone immediately underlying each articular surface. Multiplication of vessels in the initial stages of that

process is illustrated in figure 18. Tortuosity of vessels may expose the bone to a greater extent of vascular surface. Since, as already explained, tortuosity leads to congestion and stasis, the areas thus exposed may be subject to toxic fluids, with decalcifying processes resulting.

3 Decalcification. In the presence of congestion and stasis such as that illustrated in figures 12 and 13, stagnation of blood occurs. The consequent lack of ventilation and the described accumulation of gas in escaped globules both combine to make adjacent bone solvent.



Fig 18—Newly formed blood vessels penetrating the solid bone of the head of the malleus of a 20 year old man with a clinical diagnosis of otosclerosis. Congestion and stasis are present. Numerous minute clear globules are present within the lumen of the vessel. Others have escaped and are apparently enlarging as from the absorption of a gas (carbon dioxide?). No 547

4 Osteofibrosis. Following decalcification, the changes seen and the reactions noted in the tissue apparently depend on the individual constitution of the patient. Different patients react differently, according to their own constitution, once decalcification has been initiated. In figure 19 is seen an infarct on the superior surface of the incus. Fibrotic replacement of bone or osteofibrosis has occurred. The "ghosts" of the haversian canals are still apparent. In the high power view the release of



Fig 19—*A*, an area of fibrotic replacement of bone in the body of the incus. Note that the wall of a haversian canal has been completely eroded. W. F., aged 48, no 2194. *B*, detail of *A* showing bone cells freed by the decalcifying process and taking part in fibrosis. Even the former lumen of the vessel has been invaded by fibroblasts.

the bone cells is evident and their fibroblastic activity may be observed. Figures 20 and 21 illustrate similar pathologic changes occurring in the incudes of younger persons, aged 18 and 36 years, respectively.

5 Osteoporosis As stated, excessive numbers of vessels in bone produce numerous perforations. Thus the bone assumes a spongy



Fig. 20—Osteofibrosis and malformation of the incus. W. M., aged 18; no. 1756.

appearance. If the blood supply to such an area is cut off, either from prolonged stricture or embolism, the soft tissue once supplied may become atrophic, necrotic and eventually disappear entirely. Figure 22 from the case illustrated in figure 16 shows an infarct in the incus just below

the articular surface. In *A* a constricted blood vessel is seen traversing an area of osteofibrosis. In *B* the area appears as a cyst which in *C* becomes a gouged-out area in the bony contour, which is quite irregular throughout.



Fig. 21—Osteofibrosis of the incus. W. F., aged 36, no. 1701.

In figure 23 we see a malleus and an incus, both of which are osteoporotic, and this pathologic condition is directly traceable to the obliterative endarteritis that occurred in the patient as illustrated in figure 14.

6 Malformations and exostoses. In persons who are suffering from a dyscrasia of calcium metabolism, malformations of bony structures

may occur with altered stresses and strains, or calcium may be deposited in bizarre locations. In the previous paper attention was called to the distorted shapes assumed by the incus and the malleus with altered muscular activity on the ossicular chain and altered activity from inability



Fig 22 *A*—An atrophic blood vessel surrounded by an area of fibrotic replacement of bone. See figure 16. W. F., aged 50, no. 1335 *B*

to respond to sound vibration. That calcium is deposited in unusual locations is manifest in the exostoses of the disarticulated ossicles. Figure 24 illustrates this vividly, showing an exostosis on the superior surface of the incus. The line of demarcation between the normal contour and the new growth of bone is obvious. The growing bone is

highly vascular and contains large areas of fibrous tissue. It should be noted that the general staining pattern of this ossicle is irregular and that beneath the articular surface there is an extensive area of fibrotic replacement of bone. Figure 5 illustrates complete constriction of the



Fig 22 *B*—The fibrotic area gives way to a cystic space W F, aged 50, no 1335 C

vessel in the descending process of another incus. Calcium was not being normally distributed in this ossicle on account of occluded vessels, so the excess was deposited in abnormal locations.

An excellent example of the excesses to which such a pathologic process may go is well illustrated in figure 25 *A*, *B*, *C* and *D*. Here again it

is obvious that a pathologic state existed throughout this small bone. Areas of osteofibrosis and osteoporosis are numerous. Staining reactions are irregular.

7 Ankylosis. In pathologic states the deposition of calcium is uncontrolled as to location and amount. It may be deposited less abun-



Fig 22 C—Superficially the area appears as osteoporosis, neither bone nor fibrous tissue being present. W. F., aged 50, no 1335 D.

dantly but equally insidiously as flecks in the ligaments of the joints or in the interarticular disks. In such a location it may not be long before calcium accumulates sufficiently to build a bridge of bone between the two ossicles. This results in ankylosis of the ossicles as illustrated in

figure 26 *A, B, C* and *D* As may be seen in this series of pictures, vascular channels may pass from one ossicle to the other An area of osteofibrosis has also developed near the articular surface

In figure 23 we see another example of ankylosis The extent of the pathologic involvement can be fully appreciated only when the complete



Fig 23—Ankylosis of the malleoincudal joint in a case of bilateral otosclerosis See figure 11 for detail of vascular pathologic process causing this condition Osteoporosis is also present W F, aged 36, no 12 (Dr MacCready made this specimen available to us)

series of sections is studied It is obvious, however, from this illustration that another type of bony change has occurred Osteoporosis is also extensive This condition, in turn, may be traced to the vascular state which has been illustrated in figure 14, a detail of figure 23

Ossification in the area of ankylosis may be so extensive as to obliterate completely the interarticular disk. The incudostapedial joint shown in figure 27 *A* and *B* illustrates this condition. Only a small fragment of the interarticular cartilage is evident. An atrophic vessel



Fig 24—Note the exostosis or new bone formation on the superior surface of the incus. A sizable area of fibrotic replacement of bone is seen just below the articular surface. Erosion of articular cartilage has occurred superiorly. W. M., aged 22, no 1333.

is seen in the head of the stapes. Indications are that this minute vessel may have been literally squeezed shut by the presence of globules producing edema on each side of it. Further pathologic changes are to be noted in the crura. Irregular contours are present, and, in addition



Fig 25—A, pathologic incus removed at a revisory operation. Note fragments of regenerated bone in the scar tissue lying above the incus. A small exostosis is also present. W. M., aged 40, no 2060. B, another level of this incus, at which the exostosis is more extensive.

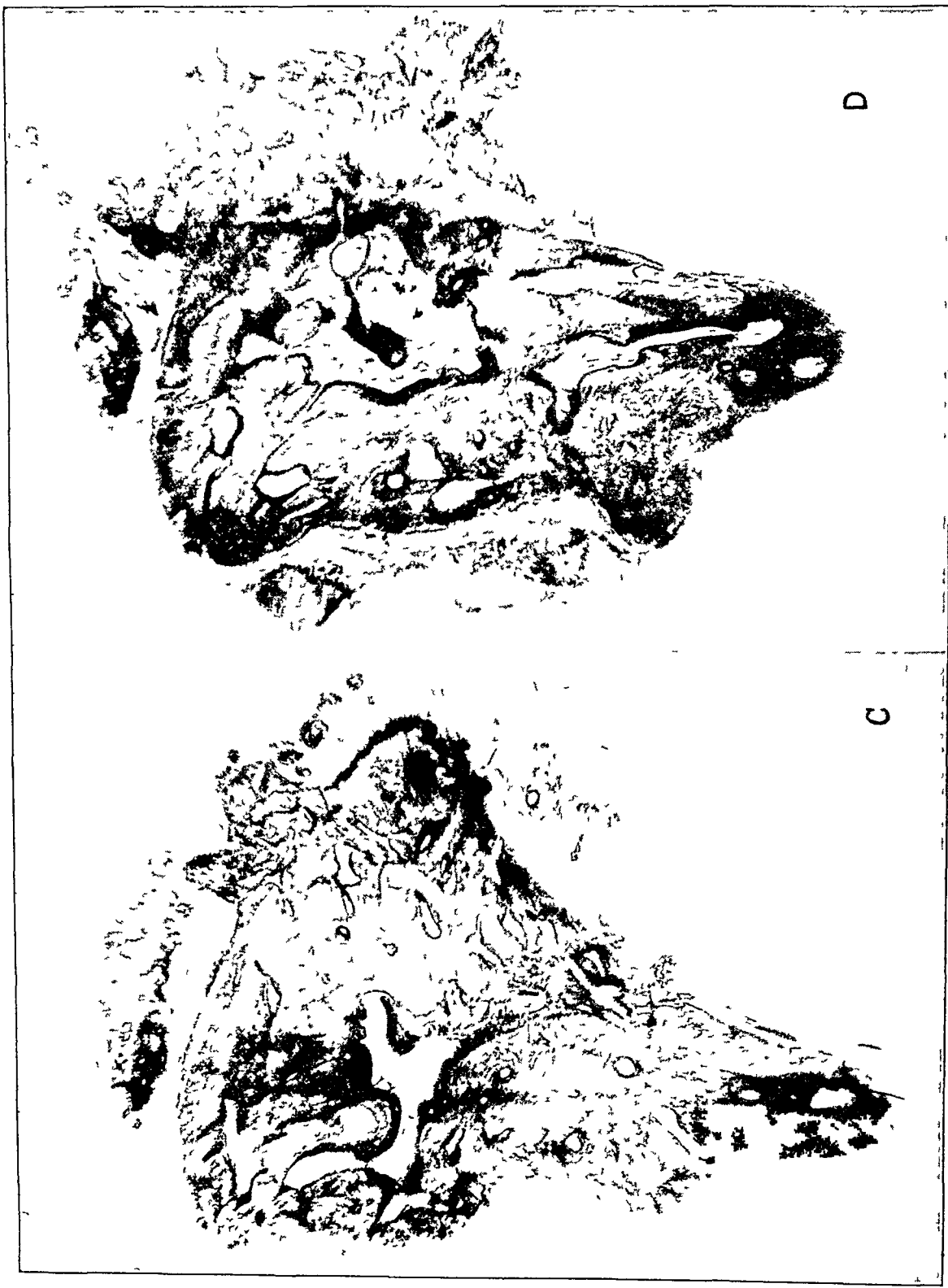


Fig 25—C, further development of the exostosis D, malformation of the incus, due to the exostosis

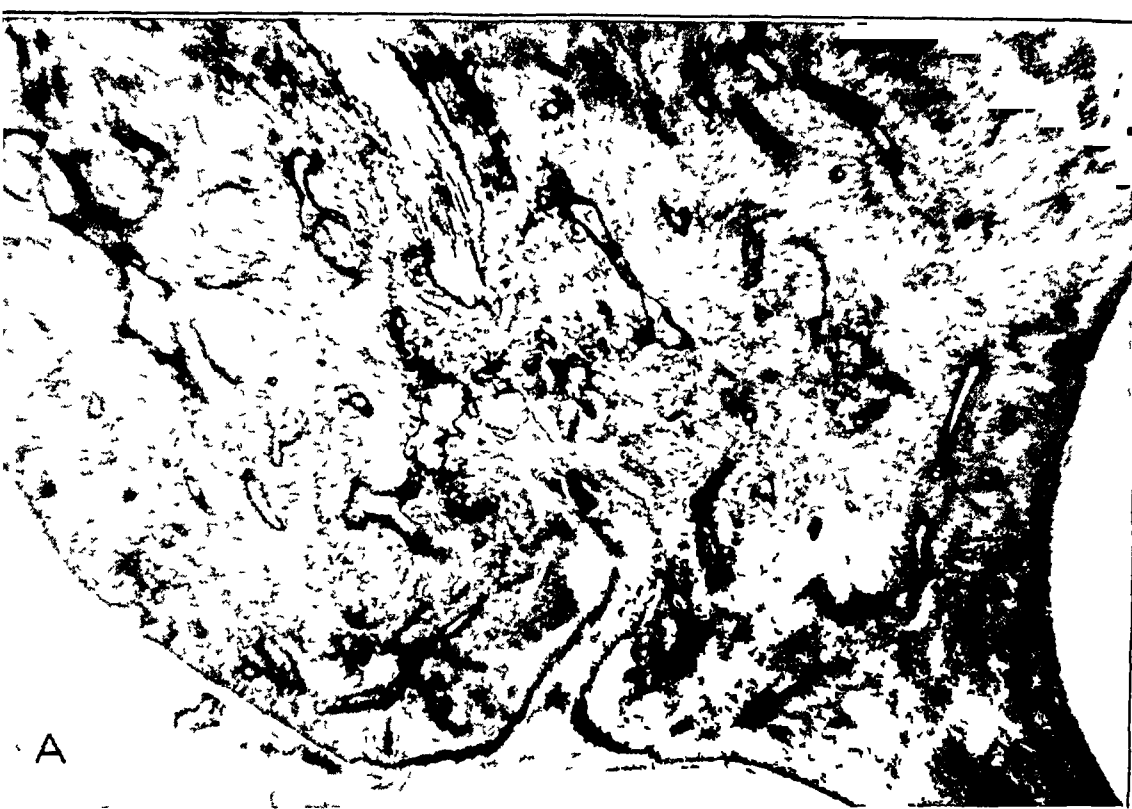


Fig 26 A—True bony ankylosis of the malleoincudal joint. Note the flecks of calcium in the interarticular disk and the area of fibrotic replacement of bone in the malleus, adjacent to the area of ankylosis. W F, aged 30, no 1784



Fig 26 B—The ankylosed area as seen at a more superficial level. Note the area of fusion of articular cartilages and interarticular disk to the right of the ankylosed area. To the left of it flecks of calcium are seen in the interarticular disk. A minute blood vessel traverses the area of ankylosis.



Fig 26 C—Just below the area of bony ankylosis an area of osteofibrosis may be seen. A sizable deposit of calcium occurs in the interarticular disk near the ligament of the joint.

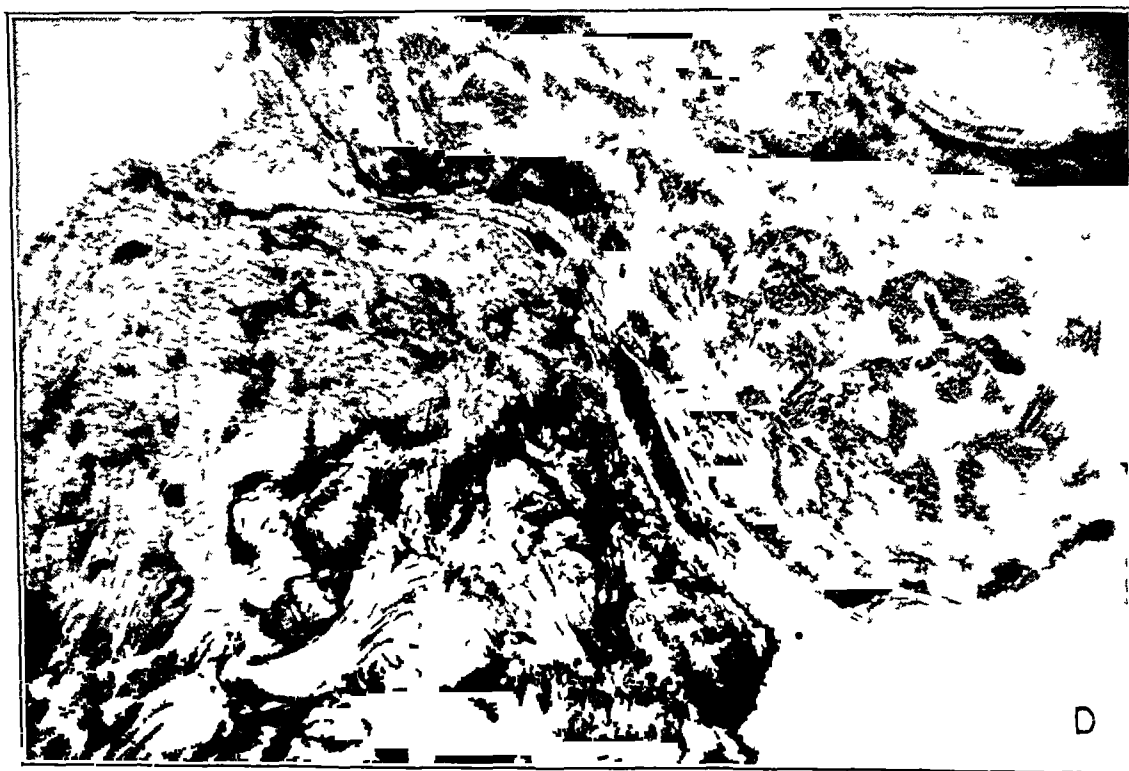


Fig 26 D—The pathologic area as seen from a very superficial level. Note the extensive calcification of the interarticular disk and the fusion of the locally contiguous cartilaginous articular surfaces.

to an overgrowth of bone, osteoporosis has developed particularly in the posterior crus. This stapes appears to illustrate an otosclerotic condition quite typically. The pathologic area extends to a higher level on the crus than is commonly seen.



Fig 27 *A*—Otosclerosis of the stapes. Note the hypervascularity and the enlargement of the posterior crus. Ankylosis of the incudostapedial joint has also occurred. W F, aged 44, no 2202.

Figure 28 *A* and *B* illustrates another stapes of a 28 year old patient. Here the head shows extensive fibrotic replacement of bone, but such a condition has been observed as an anatomic variation. However, since

it is coupled with the condition of the lower end of the crus illustrated in figure 28 *B* and a clinical history of otosclerosis one is forced to recognize a pathologic condition. Here bone has been deposited extensively by accretion.



Fig 27 *B*—Detail showing ankylosis of the malleoincudal joint. Almost complete obliteration of the cartilage of the joint has occurred. The bone has been hypervascular, but the vessels are now atrophic. W F, aged 44, no 2202.

8 Ischemia. Attention has already been called to the irregularity of the staining of the bone in these specimens. Mention has been made of occurrence of complete stricture of vessels supplying a given region. If this constriction is long lasting or permanent, necrosis of bone cells may occur. This gives the microscopic picture of pale-staining areas of



Fig 28—4, fibrotic replacement of bone in the head of the stapes B, deposition of excess bone by accretion on the lower part of the crus of stapes W M, aged 28, no 1009

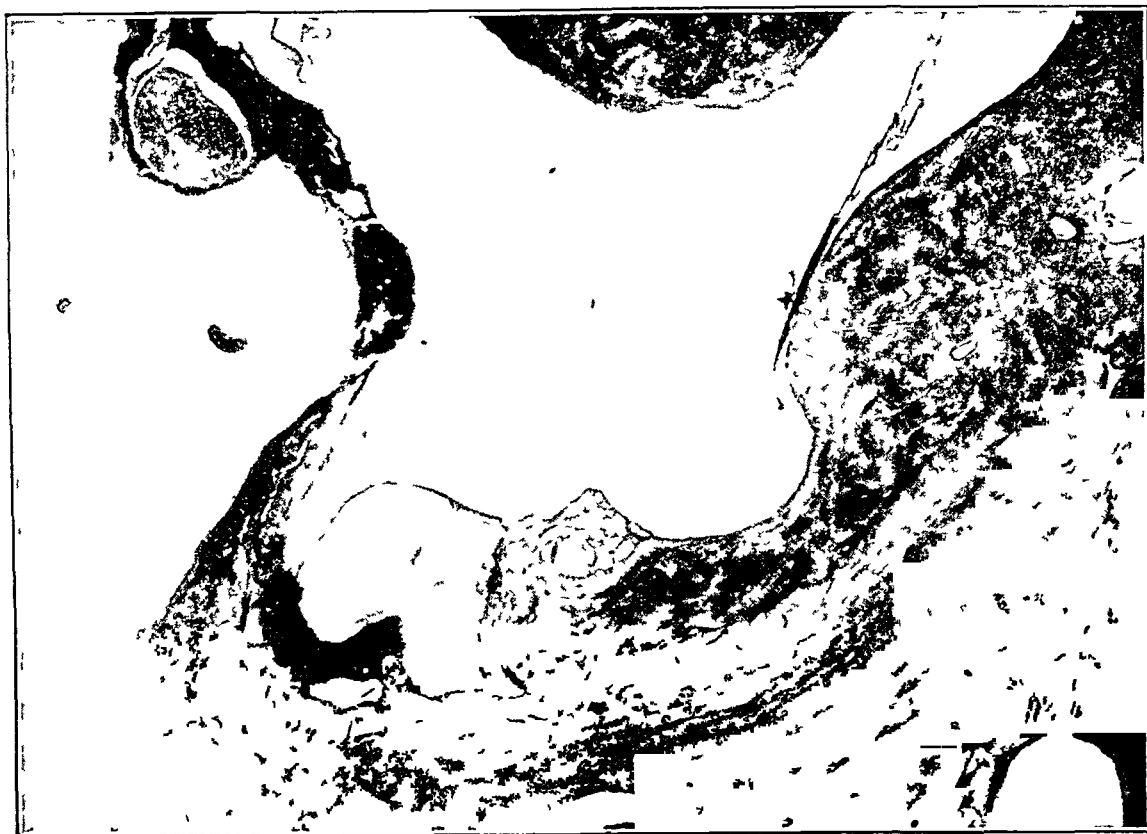


Fig 29—Otosclerosis of the footplate of the stapes in a clinically diagnosed case of otosclerosis. No ankylosis was present. No otosclerosis of the otic capsule was seen at the oval window, but otosclerotic bone is present near the round window. W F, aged 40, no 5.



Fig 30—Detail of the stapedial footplate shown in figure 29 but taken at a slightly more anterior level and showing more extensive osteofibrosis. No evidence of ankylosis occurred at any level. W F, aged 40, no 5 left ear.

bone with lacunas devoid of bone cells. As stated, such an area may lie adjacent to an area with normal vascular supply and normal staining reactions. In bone lacking blood supply the bone cells die from lack of nourishment and eventually disappear entirely, leaving empty lacunas, but the bone itself will maintain its original contour. It is bone with an abundant blood supply or an excessive blood supply that is most apt to undergo change of form.



Fig. 31—Congestion and stasis in the vessels of the malleus in otosclerosis observed in a postmortem specimen, unsuspected during life. W. M., an adult, no 5178, left ear. (This photograph was made available to us by Washington University.)

SUMMARY

Thus it may be seen from this survey of 100 ossicles removed from patients with a clinical diagnosis of otosclerosis that one small ossicle may present any one or a combination of several types of known pathologic processes of bone. There appears to be nothing specific in the kind of reaction the individual patient will give to the presence of the disease.

Decalcification occurs without the presence of osteoclasts. Only in 2 cases were any osteoclasts observed in the tissue, but areas of decalcifi-

cation were numerous and extensive. Osteofibrosis, osteoporosis, hyperostosis and sclerosis may all occur. The cubic volume of the lesion when compared with the cubic volume of the skeletal anatomy of the body is minute. But because of the strategic location of the alteration the significance of its presence is great. The types of pathologic involve-



Fig. 32—Fibrotic replacement of bone, congestion, stasis and cystic formation in the descending process of the incus in the case of otosclerosis illustrated in figure 31

ment seen in these ossicles may also be seen within the ossicles in any proved series of cases of clinically diagnosed otosclerosis examined after autopsy. The lesion, however, is not circumscribed in the ossicles as it is in the otic capsule. (See figures 29 and 31.) This we believe to be due to the anatomic difference in the blood supply. The otic capsule receives

its blood supply from six different sources (perhaps more) * The ossicles receive their blood supply from one or at most two sources. In the otic capsule, with its abundant blood supply, it is possible for a circumscribed area supplied by a certain blood vessel undergoing pathologic changes to be more or less completely surrounded by areas still receiving a normal supply of blood and therefore maintaining normal haversian systems and a normal histologic picture. The pathologic changes previously noted and the additional ones described in this paper are a part of the otosclerotic process.

We believe the vascular changes preceded the bone changes in the development of otosclerosis. We have therefore studied the blood vessels of the marrow spaces of the ossicles, the vessels of the mucosa when it was intact, the vessels of the head and neck of the malleus, the vessels of the short process of the incus and the vessels of the descending process of the incus. The condition of the walls of these vessels was examined. The histologic vascular content was also examined. The pathologic changes observed were found to lead in more or less logical and chronologic steps to the various types of bone disease described.

Changes of Vascular Content

- 1 Clear globules
- 2 Accumulating fragmented red blood cells
- 3 Sludge
- 4 Accumulating polymorphonuclear cells

Changes of Vascular Wall

- 1 Constriction of vessels the caliber of which is normally that of capillaries supplying bones elsewhere in the body
- 2 Tortuosity of vessels caused by
 - (a) Hypertrophy of endothelial cells
 - (b) Varicosities
- 3 Periarteritis
- 4 Endarteritis

Changes of Bone

- 1 Excessive blue mantling
- 2 Hypervascularity
- 3 Decalcification
- 4 Osteofibrosis
- 5 Osteoporosis
- 6 Hyperostosis with malformations
- 7 Ankylosis of joints
- 8 Ischemia with empty lacunas

CONCLUDING COMMENT

A survey of pathologic changes seen in ossicles from 215 patients with a clinical diagnosis of otosclerosis leads us to believe that these

ossicles do show otosclerosis but not in the clearcut circumscribed form we had anticipated. Believing that in studying a large number of ossicles from these patients we might see progressive stages of the disease, we have here attempted to present the findings somewhat in a possible chronologic order.

We have demonstrated microscopic evidence of ankylosis in the incudostapedial and incudomalleolar joints of these ossicles. We believe the initial pathologic changes are within the blood stream.

Age Distribution of 100 Patients Whose Ossicles Have Been Histologically Examined

Between 12 and 20	20 29	30 39	40 49	50 59	60 69
18	29	36	43	52	63
	29	35	44	57	
	29	37	40	52	
	26	38	41	54	
	23	34	42	55	
	27	36	44	51	
	20	39	41	50	
	22	39	43	52	
	29	39	40		
	24	34	45		
	26	31	48		
	29	35	40		
	22	37	40		
	29	32	45		
	28	31	40		
	22	31	41		
	29	38	43		
	27	38	40		
	23	31	42		
	29	34	44		
	20	38	41		
	28	33	46		
	27	35	49		
		36	46		
		34	43		
		30	48		
		30	42		
		37	44		
		37	44		
		36	41		
		38	44		
		34	43		
		37	46		
			49		

We have taken into consideration the possibility that senescence plays a part in the production of the pathologic changes described. However, a survey of the decades of life represented in this series of patients precludes the possibility that geriatric conditions are a factor. We are dealing with a group of young persons, as may be seen in the table.

INHALATION OF PENICILLIN AND STREPTOMYCIN IN OFFICE PRACTICE

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WASHINGTON, D C

THE INHALATION treatment of respiratory diseases has been known for centuries. Steam has been used by itself or with various volatile drugs, such as camphor or menthol, for many years. Shortly after Koch announced his discovery of the tubercle bacillus, someone advocated the inhalation of a culture of another organism to kill the tubercle bacilli in the lung. Following World War I, inhalation of chlorine gas was in vogue as a remedy for a cold in the head or the chest. The more recent use of inhalations of epinephrine for relief of asthma is known to everyone, and today almost every medical journal has an article about the inhalation of penicillin or streptomycin for some respiratory or general condition. It is only natural that the antibacterial drugs should be used by inhalation, for with this method they are delivered directly to the site of infection and in a concentration sufficient to be effective against susceptible organisms.¹

Today the problem is to determine the best method of inhalation, that is, the type of inhaler, the proper drug, the correct amount and the best diluent, if any.

In this paper I shall confine my remarks to the inhalation of nebulized penicillin and streptomycin as applied in office practice and in the home.

The inhalation of penicillin is now recognized as an effective treatment for various infections of the upper and lower respiratory tract. It is probably the simplest method of reaching all of the respiratory mucosa at one time with a drug that is effective against gram-positive bacteria. Diseases of the respiratory tract which are amenable to

Read before the Section on Laryngology, Otology and Rhinology at the Ninety-Seventh Annual Session of the American Medical Association in Chicago, June 24, 1948.

1 (a) Abramson, H. A. Principles and Practice of Aerosol Therapy of the Lungs and Bronchi, *Ann Allergy* **4** 440-456 (Nov-Dec) 1946. (b) Bryson, V., Sansome, E., and Laskin, S. Aerosolization of Penicillin Solutions, *Science* **100**: 33-35 (July) 1944. (c) Findeisen, W. Ueber das Absetzen kleiner, in der Luft suspendierter Teilchen in der menschlichen Lungen bei der Atmung, *Arch f d ges Physiol* **236** 367-379, 1935.

office inhalations of penicillin are rhinitis, sinusitis, nasopharyngitis, pharyngitis, laryngitis, bronchitis, bronchiectasis, infectious asthma and contact ulcer of the larynx. Not all patients are relieved or cured, but the method is effective enough to be included in one's armamentarium. There are many other respiratory conditions which are reduced by nebulized penicillin, such as pneumococcic or streptococcic pneumonia, pulmonary abscess and acute laryngotracheobronchitis, but these are not suitable for office treatment and are not discussed in this paper.

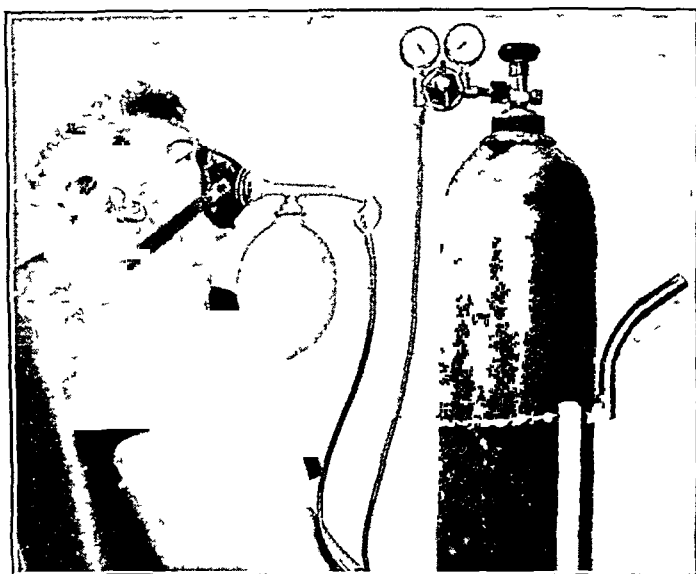


Fig 1—Pen-I-Sol nebulizer with face mask and rebreathing bag. It is used in all conditions other than sinusitis. A pressure machine can be used instead of the oxygen tank. (Made by the Oxygen Therapy Sales Company, Los Angeles.)

APPARATUS AND TECHNIC

The apparatus used in my office is simple. It consists of a nebulizer connected with a face mask and a rebreathing bag and a tank of oxygen which supplies the pressure to nebulize the penicillin (fig 1). If sinusitis alone is to be treated, nasal tips and a suction-pressure apparatus (fig 3) are used instead of the face mask and the rebreathing bag. The penicillin is dissolved to make a concentration of 150,000 units in 0.75 to 1 cc of distilled water, isotonic solution of sodium chloride or phenylephrine hydrochloride N N R and is placed in the nebulizer, when this is entirely used up 0.5 cc of distilled water or the saline solution is put into the nebulizer and inhaled to utilize the penicillin which has adhered to the sides of the apparatus. As much as 250,000 to 300,000 units of penicillin may be used at one time, in such cases it is advisable to use up to 1.5 to 2 cc of the diluent. Since penicillin G has been used, there is no discomfort with inhalation.

of the larger number of units Barach and co-workers² have devised a tablet containing 50,000 units of crystalline G penicillin. As many as 4 tablets will dissolve in 1 cc of distilled or boiled water. The tablets are placed in the nebulizer and the water added to make the solution.

Treatments are given at the rate of one a day at least and in some cases two a day for several days, depending on the severity of the condition and the response of the patient. In most cases that are not chronic I advise the patient to take at least one treatment daily for six days, and not to be disappointed if the disease does not show any response until that number has been taken. Frequently patients will state after the third or fourth treatment that the condition is no better, but many of the same patients will volunteer the information that they feel better or cured after the fifth or sixth treatment. Chronic conditions may require many more than six treatments. The number must be judged by the patient's response or by the results of various examinations, including bacteriologic and roentgenologic examinations.

Organisms may become resistant to both penicillin and streptomycin, and this may be a reason why some infections do not respond to the inhalations. To overcome this, it is necessary to use a sufficiently large dose of the antibiotic in the beginning of the treatment. Ordinarily one need not consider the resistance of the organisms to penicillin, but at times the resistance to streptomycin becomes so great that it cannot be overcome even with very large doses.

OBSERVATIONS

The respiratory tract conditions most amenable to penicillin inhalations are those due to gram-positive bacteria, particularly the streptococci and pneumococci. Even a cold in the head will often respond to the inhalations. One does not use the inhalations routinely in treating colds, as these are self limited, but on trying the inhalations at the request of the patients, I have been agreeably surprised to find that some of them are relieved promptly of their symptoms. The nurse employed in my office can relieve herself of colds with one or two inhalations, the secretary gets no relief from them.

Infections of the nasopharynx, which are difficult to treat in some patients, often respond to the penicillin aerosol. This result is probably due to the effect of the penicillin on the infection of the nares or the sinuses which so often accompanies or precedes nasopharyngitis. The aerosol makes it unnecessary to swab the nasopharynx and also prevents the infection from spreading downward. If there is any secretion in the nose, this is removed by suction, and if necessary a decongestant such as phenylephrine hydrochloride or an ephedrine salt is sprayed into the nares. Taking one or two inhalations a day for about two days is usually sufficient.

² Barach, A. L., Rumsey, C. C., Jr., Soroka, M., and Radar, D. A Simplified Technic of Treating Sinusitis with Penicillin Aerosol, with Description of Foot Pump for Economical Nebulization of Penicillin and Other Therapeutic Aerosols, *N. Y. State J. Med.* **47** 1498-1500 (July 1) 1947.

Laryngitis is effectively treated with inhalations of penicillin, particularly in the acute stages. Often a speaker or a singer can get relief in one to four inhalations and is then able to speak or sing without difficulty. This type of treatment is most gratifying, as it is so simple as compared with any other method of instilling medicine into the larynx. In cases of acute laryngitis the patient is asked to take two treatments a day, in that way inhaling 300,000 units of penicillin. At the end of the second day or the fourth inhalation the hoarseness is usually so much improved that the patient can carry on in a normal voice.

The most striking results are seen in cases of cough due to acute bronchitis or occurring as an aftermath of that condition in which all other remedies have failed. Most of the patients have tried various cough medicines, inhalations of steam, drops in the nose, gargles, etc., without avail. Many are children with soggy nares, postnasal discharge, lymphoid tissue on the posterior part of the pharynx or enlarged lingual tonsils, with a constant hacking or even a productive cough. Treating cough in children is especially important to prevent bronchiectasis. After a few treatments with the nebulized penicillin these patients are greatly improved and many are entirely relieved. It may be necessary to give as many as ten treatments to get a good result, but most patients are improved in less than that number. It is suggested that patients with bronchitis or cough be examined by their physicians before the inhalations are started. This is no problem, as most of the patients have already been under treatment with their family physicians, who are glad to have them get the inhalations. Occasionally, a good result is obtained in the patient with a cough that has not cleared up under inhalations of penicillin by adding streptomycin, 0.3 Gm., to the penicillin or substituting streptomycin for the penicillin. Patients with cough are forbidden to smoke, as smoking can undo all the good effect of the inhalations. If there is any reason to believe that bronchiectasis is present, bronchograms are taken, and a bacteriologic examination of the coughed-up secretion is made. Often these bronchiectatic patients cough up phlegm containing gram-negative organisms which are more effectively treated with streptomycin than with penicillin.³ In these cases I feel that the combination of penicillin and streptomycin is better than either one alone. When penicillin alone is used, the gram-negative organisms may not be affected. They in turn elaborate an enzyme, "penicillinase," which destroys some of the

3 Olsen, A. M. Inhalational Therapy in Bronchiectasis, *J. A. M. A.* **134**: 947-952 (July 12) 1947.

bacteriostatic activity of penicillin⁴ By the addition of streptomycin to the penicillin aerosol the gram-negative organisms are affected, and this prevents the production of penicillinase When possible I try to get these patients to take two treatments daily, to get 300,000 to 500,000 units of penicillin and 0.6 to 1 Gm of streptomycin a day Before the inhalation is given the bronchi are emptied by postural drainage In these chronic cases the number of treatments depends on the response—usually a month is a fair length of time to give them before expecting any lasting results, but many of these patients will feel better and have less expectoration, with elimination of the odor, after even a few treatments It is recommended that these inhalations be given preliminary to surgical treatment of bronchiectasis, in order to prevent complications during and after the operation Inhalations are especially effective in bronchial conditions, as the drug is placed directly at the sites of infection As Segal⁵ said, "The clinical course is sufficient proof of the topical effectiveness of penicillin aerosol"

Patients with sinusitis may get much relief from inhalation of penicillin This treatment is valuable in cases of generalized sinusitis complicating a head cold when the condition is too acute to warrant much if any nasal or sinus treatment If the nose is clogged, a vasoconstrictor is sprayed into both nares, and if mucus or pus is present, this is removed with a fine suction tube The penicillin dissolved in 0.25 per cent phenylephrine hydrochloride solution instead of saline solution or water is then inhaled through nasal tips inserted tightly into the vestibules The nasal apparatus² works by the alternating pressure and suction provided by a Venturi tube, and in this way the penicillin is inhaled directly into the sinuses Most acute involvements will clear up after a few inhalations, the head feels clear, the headache is gone and the patient experiences a sense of well-being which is not achieved by the usual nasal treatments Whether this is due to the effect of the oxygen or to the thorough shrinking with the phenylephrine or to the effect of the penicillin I do not know Even purulent sinusitis may respond to the inhalations and thus obviate the necessity of irrigations of the sinuses, although a combination of irrigations and inhalations is at times necessary to clear up some of these purulent sinuses One patient, a boy of 14 years, had generalized purulent sinusitis complicated with bilateral otitis media and mastoiditis

4 Abraham, E. P., and Chain, E. Enzyme from Bacteria Able to Destroy Penicillin, *Nature*, London **146** 837 (Dec 28) 1940 Woodruff, H. B., and Foster, J. W. Microbiological Aspects of Penicillin VII Bacterial Penicillinase, *J. Bact.* **49** 7-17 (Jan) 1945

5 Segal, M. S. Inhalational Therapy in Treatment of Serious Respiratory Disease, *New England J. Med.* **229** 235-241 (Aug 5) 1943, *Medical Progress Inhalation Therapy* **230** 456 (April 13) 1944

The left mastoid process had to be exenterated. It continued to drain after the operation. The tonsils and adenoids were removed, and the maxillary sinuses were irrigated on several occasions, with the recovery of much mucopus, but the nose remained full of mucopus and the ears discharged as before. Penicillin had been given by injection and sulfadiazine by mouth in large amounts without any apparent effect. Penicillin aerosol was then tried, and the secretion in the nose and the ears dried up within one week. Irrigation of the maxillary sinuses following one week of inhalations of penicillin showed them to be free of secretion.

Patients often come into the office with a self diagnosis of "sinus," and on examination not much is found to account for their stuffiness and headache or discharge. Allergy may account for the discomfort of some of these. Some of them actually have low grade sinusitis, manifested by a hyperplastic nasal membrane and clouding of the sinuses on transillumination, and have not responded to previous treatments of nose and sinus. In these cases inhalations of penicillin dissolved in 0.25 per cent phenylephrine hydrochloride solution give the patients the relief they seek, although in some not much change of the mucosa can be noted following the treatments. After about the fifth or sixth treatment they will usually volunteer the information that they feel relieved. In some the sense of smell returns, which had not been present for years.

In some patients chronic purulent sinusitis responds well to the inhalations, but the patients are told not to expect any miracle. Many of them have had different kinds of intranasal treatments and usually surgical interventions. They have long since given up hope of relief and refuse further manipulation of their noses. Any improvement experienced through inhalations is most welcome, and the ease with which the treatments are given is appreciated. It is necessary with some of these patients to aspirate the secretion and to spray in a decongestant before using the inhalations. Cultures are taken also, to determine the antibiotic to be used. Usually the organisms are gram positive and penicillin alone is effective, but if any gram-negative organisms are found or if there is no response to penicillin alone, streptomycin is added. Some patients who have had completely dark or cloudy sinuses on roentgenograms for years, with discharge, stuffiness, headache and other discomforts, are relieved symptomatically, and their sinuses show on roentgen examination a clearing which was hardly expected. With some of these patients it is necessary to irrigate the maxillary sinuses to remove the heavy secretion at some time during the course of their inhalations, but in others the suction-pressure inhalations alone are sufficient to empty the sinuses. In these the

results are particularly gratifying, as up to now no treatment has offered more than temporary relief

Some asthmatic patients are helped by inhalations of penicillin, particularly those whose asthma is due to infection. The penicillin is dissolved in 1 per cent phenylephrine hydrochloride solution instead of water or saline solution, and this may also be a factor in giving relief. The effect of the penicillin on the infection of the paranasal sinuses which accompanies the infectious asthma in some of these patients probably plays an important part. Many of the patients have had surgical treatment which has failed to relieve their asthmatic symptoms, in part because it does not eradicate all the foci of infection. In these patients nebulized penicillin probably reaches the hidden areas of infection in the sinuses and also in the bronchial tree, and on the elimination of these the asthma is relieved.

As time goes on other conditions are treated, with gratifying results. The inhalations are now being used in cases of contact ulcer of the larynx with good effect. Silence alone is of value, but the recovery is discouragingly slow. By adding inhalations of penicillin to the treatment one is able to eliminate the infection not only in the ulcer but in the upper respiratory tract which may contribute to the prolongation of the condition. The patient also feels that the doctor is doing something active for him besides advising him to keep silent. This course was suggested to me by Dr. Samuel Crowe, of the Johns Hopkins University, and is proving to be successful.

Acute tonsillitis and pharyngitis can be reduced by inhalations of penicillin, either through the local effect or through the absorption of the penicillin into the blood stream. The results are difficult to determine, as other remedies are combined with the penicillin inhalations, and also the condition clears up in a short time under almost any kind of treatment. The inhalations help by removing any infection which may be present in the nose and the nasopharynx and which may contribute to the continuation of the condition of the throat.

The ease of administering the inhalations is also a factor in their favor. Patients practically give themselves the treatments. After the initial examination, if the doctor prescribes inhalations, the nurse adjusts the apparatus to the patient's face or nose, and after the penicillin aerosol has been inhaled, she adds 0.5 cc. of distilled water or saline solution to the nebulizer in order that the penicillin which clings to the inner surface of the apparatus may be utilized. When the patient returns for further inhalations, the nurse gives the treatment and the doctor needs to spend only a minute or two to see how the patient is getting along. If there is any secretion in the nose which should be aspirated, this is done, and a decongestant is sprayed in before the inhalations are begun. If there are any cutaneous irritations, such

as urticaria, or any asthmatic symptoms following any of the inhalations, the inhalations are either discontinued or another type of penicillin is used. Asthmatic attacks occur seldom but may be severe and are treated with antihistamine drugs, such as diphenhydramine hydrochloride (benadryl hydrochloride®) or tripeleminamine hydrochloride (pyribenzamine® [N'-pyridyl-N'-benzyl-N-dimethylethylenediamine]). Irritation of the mouth has not occurred since a humidifier was attached to the oxygen tank. However, if one uses a nebulizer held between the lips—i e., without a mask—it is advisable to rinse the mouth after the treatment. Penicillin urticaria can be treated with nicotinic acid, 35 mg in 8 to 10 cc of distilled water being injected intravenously.⁶ Segal⁷ suggested changing to another type of penicillin when these local reactions occur.

OTHER TYPES OF APPARATUS

There are several types of apparatus other than the pen-i-sol® nebulizer, with rebreathing bag and mask (fig 1), made by the Oxygen Therapy Sales Company, Los Angeles, and the negative pressure sinus apparatus, made by the Inhalational Equipment Company, Inc., New York, which I use. McAuliffe and Mueller⁸ have devised a suction-pressure machine which works with an electric motor. Nebulizers made by the Inhalational Equipment Company, Inc., the Oxygen Equipment Manufacturing Corporation and the Vaponefrin Company, as well as the DeVilbiss nebulizer No. 40 and the Parke, Davis & Company epinephrine inhaler are all satisfactory and are supposed to deliver particles between 0.5 and 2.5 microns in size. For home use there are several types of apparatus available. The Abbott Laboratories have devised a small plastic atomizer to be used with micronized penicillin dust instead of penicillin solution (fig 5). A small cartridge of 300,000 units of finely divided penicillin is inserted into the apparatus, and the penicillin dust is breathed in through either the mouth or the nose. Krasno⁹ reported that several hundred patients had used this apparatus with good results and no side effects. However, several of my patients have had severe reactions after using this type of apparatus. Their noses became congested and the skin of the nose and lips red and swollen. They felt as if they had a severe cold in the head.

6 Service, W. C. The Treatment of Penicillin Urticaria with Nicotinic Acid, *Ann Allergy* **4** 397-398 (Sept-Oct) 1946.

7 Segal, M. S., and Ryder, C. M. Penicillin Inhalation Therapy, *New England J Med* **236** 132-138 (Jan 23) 1947.

8 McAuliffe, G. W., and Mueller, G. C. Aerosol Penicillin Administered in Paranasal Sinusitis with Balanced Suction and Pressure, *Arch Otolaryng* **46** 67-71 (July) 1947.

9 Krasno, L. R., in discussion on Davis, D. Inhalation of Penicillin and Streptomycin in Office Practice, *Tr Am Acad Ophth* **52** 273-282 (March-April) 1948.



Fig 2—Vaponefrin® plastic mask and plastic nebulizer without rebreathing bag
It is used in the same way as the apparatus shown in figure 1 (Made by the Vaponefrin Company, Upper Darby, Pa)

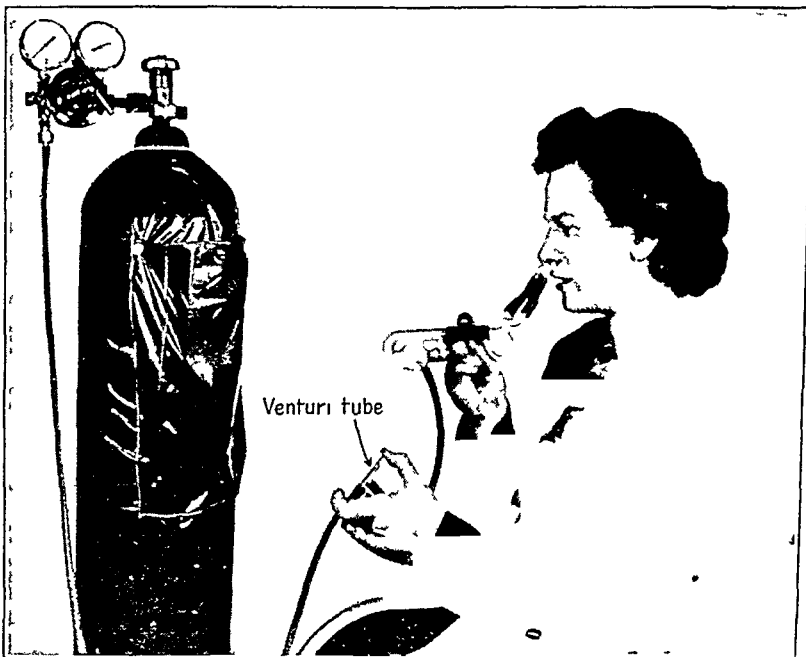


Fig 3—Simplified negative pressure sinus unit This is similar in action to the sinusilin® apparatus described in my previous paper (Davis, D Inhalation of Penicillin and Streptomycin in Office Practice, Tr Am Acad Ophth 52 273-282 [March-April] 1948) (Made by the Inhalational Equipment Company, Inc, New York)

•Barach, Rumsey, Soroka and Radar² have recently added a foot pump apparatus to their negative pressure sinus apparatus. This apparatus replaces the oxygen tank and allows the inhalations to be used at home with less expense to the patient. The nebulizer is fitted with nose pieces and a metal Venturi tube, and there is no rebreathing bag. I do not believe that it will become popular.

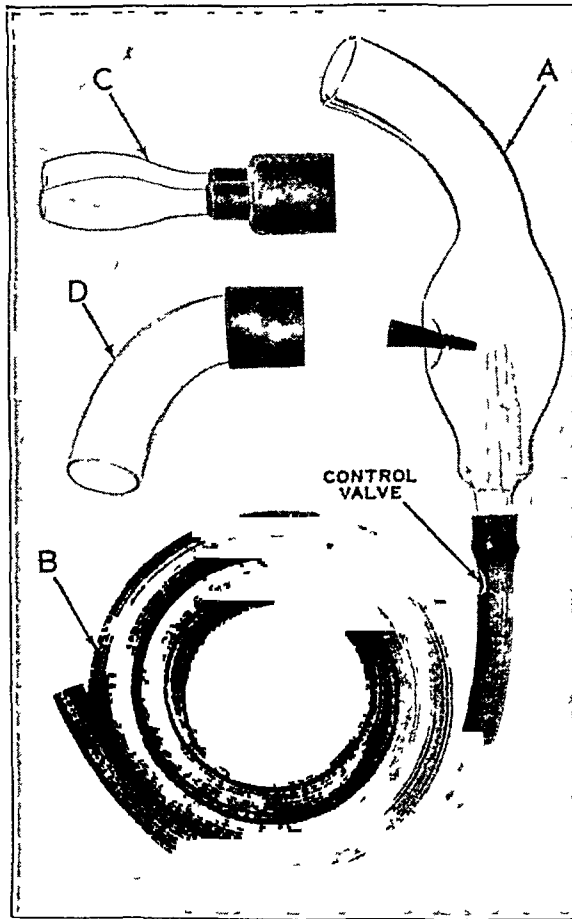


Fig 4—DeVilbiss no 40 nebulizer for mouth (A) or nasal (C) inhalation. Instead of the long tube (B) which connects with an oxygen tank, a hand bulb can be attached directly to the nebulizer for home use. (D) is a glass tube which connects with (A) for use when the patient is lying in bed and cannot sit up.

Finke¹⁰ has advocated the use of a bicycle pump to supply the air to nebulize the penicillin for home treatment. Prigal and associates¹¹ have devised a combined steam generator and nebulizer which can be used in the office or in the patient's home (fig 6). Prigal stated

10 Finke, W. Simplification of Penicillin Aerosol Therapy for Home Treatment, *Am Pract* 1:643-644 (Aug) 1947.

11 Prigal, S. J., McGavack, T. H., Speer, F. D., and Harris, R. Aerosol Penicillin, *J A M A* 134:932-938 (July 12) 1947.



Fig 5—Plastic apparatus made by the Abbott Laboratories and introduced by Drs Krasno and Karp. It may be used by mouth or nose. There are several plastic aerosol apparatuses now available, such as the Squibb dispulator[®] and the Upjohn inhalator[®].

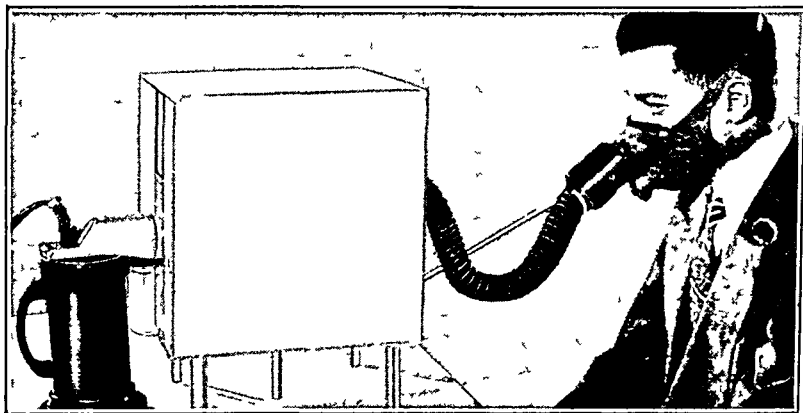


Fig 6—Apparatus devised by Dr S J Prigal¹¹. Pressure is supplied by steam.

that "satisfactory aerosols were readily obtained from solutions of theophylline ethylenediamine [aminophylline U S P], epinephrine, sulfadiazine and penicillin—singly or in combination" He stated that he uses propylene glycol as a solvent for the penicillin and that "the use of a combined penicillin-propylene glycol aerosol under a tent provides a means of obtaining rapid and prolonged levels of penicillin in the blood" Senturia and Doubly¹² stated, however, that "propylene glycol completely inhibited the antibacterial action of penicillin and was incompatible with streptomycin" *in vitro* Until this question is finally settled I have discontinued using propylene glycol as a solvent



Fig 7—Plastic hood that is useful in the treatment of infants and young children (Made by the Oxygen Therapy Sales Company, Los Angeles)

for penicillin and streptomycin and use either isotonic solution of sodium chloride, distilled water or phenylephrine hydrochloride

For the treatment of infants and small children who cannot use the face mask or the suction-pressure apparatus there is a plastic hood which when tucked around the head and neck makes an airtight tent into which the penicillin aerosol can be piped (fig 7) This works

¹² Senturia, B H, and Doubly, J A Treatment of External Otitis Use of Vehicles and Antibiotics in External Auditory Canal, *in Vitro Studies*, Laryngoscope **57** 633-656 (Oct) 1947

much like the oxygen tent used in hospitals but is smaller and can be used in the office or the home. Because of the short duration of the treatment, it is not necessary to cool the aerosol penicillin, and the patient soon learns to accept the treatment without much resistance.

Compressed air may be used instead of oxygen, and, according to some observers, there is practically no difference in the results. In my office compressed oxygen is still used, as this has proved satisfactory and gives the patient a feeling of well-being not experienced with compressed air.

No doubt many other drugs and antibiotics will be used by nebulization or are already being used, such as bacitracin, hydrogen peroxide,

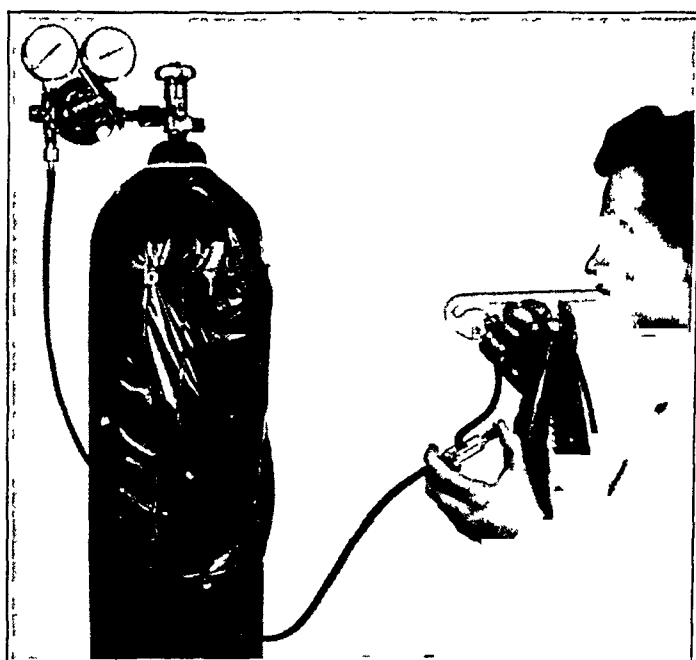


Fig 8—Nebulizer with manual demand valve and rebreathing bag. This is made also without the rebreathing bag. Instead of the demand valve which saves oxygen, a Y tube may be used. The Y tube is open during expiration and closed during inspiration. (Made by the Inhalational Equipment Company, Inc., New York.)

chlorophyll, aminophylline and iodized oils. As better apparatus is devised and new drugs are discovered, aerosol therapy, I feel sure, will be even more firmly entrenched in the program of eradicating disease.

SUMMARY AND CONCLUSIONS

Inhalation therapy is recognized as an effective treatment for various infections of the upper and lower respiratory tracts. It is a simple method of applying drugs to the entire respiratory mucosal tract in sufficient concentration to be effective against bacteria.

The drugs most commonly used are penicillin and streptomycin. Bacitracin, hydrogen peroxide, urea peroxide, the sulfonamides, chlorophyll, aminophylline, iodized oil and others are also used effectively.

The apparatus consists of a nebulizer, which connects with a face mask and a rebreathing bag, and a tank of oxygen, which supplies the pressure. Compressed air can be used instead of the oxygen. For sinus treatments, nasal tips and a suction-pressure apparatus are used instead of the face mask and the rebreathing bag.

Inhalation treatment is effective in cases of acute or chronic sinusitis, nasopharyngitis, pharyngitis, tonsillitis, laryngitis, bronchitis, bronchiectasis, cough and infectious asthma. Even colds in the head frequently respond to the inhalation of penicillin.

In cases of infection of the respiratory tract due to gram-positive organisms, penicillin aerosol alone is effective. If gram-negative organisms are present, streptomycin, alone or combined with penicillin, is used. The inhaling of 150,000 units of penicillin once or twice a day for six days or less is usually sufficient to reduce most acute or subacute conditions. For chronic ones, such as bronchiectasis or chronic sinusitis, daily treatments may be necessary for thirty days or longer. If streptomycin is used, 0.3 to 0.5 Gm., alone or combined with penicillin, is given.

Treatments may be taken at home with any one of the various types of apparatus described.

Infants and small children can be treated through a plastic hood tucked around the head and neck.

1835 I Street, N. W.

ABSTRACT OF DISCUSSION

DR. ALVAN L. BARACH, New York. As Dr. Davis has outlined, there is evidently considerable value in the inhalation of penicillin mist in office practice. It is true that difficulties are encountered in interpreting the effect of penicillin aerosol under negative pressure in acute sinusitis. In a good many of the patients the conditions clear up under conservative measures, but in regard to those with chronic sinusitis an opportunity is afforded to test the effect of negative pressure in conjunction with penicillin aerosol in patients who have had histories of suppurative disease for five, ten or fifteen years.

I should like to show a few slides of people who have been treated over a period of years.

This is the picture of ethmoid sinusitis in a girl treated in a series at the Presbyterian Hospital in a study conducted by the nose and throat department, with Dr. Glass, and the department of medicine, with Dr. Pons and Dr. Garthwaite.

This patient not only obtained complete clearing away of a chronic nasal discharge but also, quite interestingly, was transformed from what appeared to be a behavior problem—a girl who seemed like a spoiled child, very alienating, into one of the most attractive, cooperative patients in the clinic.

She was given 200,000 units of penicillin once a day in a 1 per cent solution of an ephedrine salt. From our experience, three to four treatments per day are preferable.

A boy who had suffered from chronic sinusitis for fifteen years and whose sinuses had been irrigated many times, was hospitalized and after twelve days was free of the symptoms of purulent chronic sinusitis.

One of the interesting things is the disappearance of cough which often takes place in these cases, not caused by bronchitis or bronchiectasis, this is due to the treatment of the nasopharyngitis which, I think, is often present.

DR SAMUEL J. PRIGAL, New York. I agree with what was said by Dr. Davis and Dr. Barach concerning the value of penicillin aerosol in the treatment of respiratory infections. However, I have used a different method of therapy.

It was my belief that it was wasteful and costly to employ oxygen merely as a driving force, therefore, I sought a cheaper method of producing aerosols and began to use a steam generator, using the force of steam to create the aerosol. I have developed an apparatus which is efficient and does not necessitate repeated replacement of oxygen. With the combined steam generator and aerosolizer, one simply goes to the sink for a refill.

Having produced an aerosol which was inexpensive, I next faced the problem how to make that aerosol last long enough to enable one to make good use of it. This was achieved by employing propylene glycol as a solvent for the penicillin.

Any aqueous aerosol which one may produce evaporates. The finer the aerosol the greater the surface and therefore the greater the evaporation. With this steam generator which Dr. Davis mentioned, using propylene glycol as a vehicle in which various medicaments are dissolved, I can produce an aerosol which will last an hour, if desired. It enables me to treat patients under a tent or in a small chamber at home, i. e., the bathroom. I like the bathroom treatment for children particularly, because it frequently enables me to treat simultaneously a mother or a father who may act as a carrier, along with the child. I select for treatment the parent who on examination shows evidence of being responsible for repeated reinfection of the child.

The next problem was that of confining the aerosol in such a way as to give the patient the maximum use of it. I confined the patient in the bathroom or in a small chamber and blew the aerosol in. I have also used tents, but the most effective and efficient method is the one in which I use what I call a breathing box. The aerosol dissolved in propylene glycol is blown into this box, and the patient inhales from this box by means of tubing and a mask. With the use of either the tent or this breathing box, it has been possible to demonstrate penicillin in the blood in high concentration for six hours. It has enabled me to use this method as an adjunct to the giving of continuous penicillin therapy for systemic disease. It also means for me that I do not have to treat my patients every two or three hours. Severely ill patients are treated twice daily, rarely more times, most patients receive only one inhalation daily.

Steam in itself, in addition to penicillin or streptomycin, has such value that it is of special merit to the practitioner of otolaryngology.

DR DAVID DAVIS, Washington, D. C. I should like to show a few slides to illustrate the apparatus I talked about. I might mention some of the apparatus which can be used at home. Dr. Barach has devised a foot pump to supply the power for the nebulizer, and Dr. Fink uses a bicycle pump. I have had no experience with these. I often advise home inhalations in addition to the inhalations given in the office and think I get better results.

Dr Barach's apparatus consists of a nebulizer with nasal tips. It has a Venturi tube attached to rubber tubing leading from the oxygen tank in order to get alternate pressure and suction. When the Venturi tube is closed, oxygen goes through the nebulizer and the patient breathes it through his nose. When the patient removes his finger from the tube, allowing it to open, the oxygen escapes, leaving a vacuum in the apparatus. The patient swallows at the same time, the soft palate closes the nasopharynx and this creates a vacuum in the nose and sinuses. Then when the patient puts his finger on the Venturi tube and closes it, penicillin and oxygen are inhaled into the nose and the sinuses. This procedure is repeated many times during the treatment and is effective in the treatment of infected sinuses.

A DeVilbiss nebulizer can be used at home with a hard bulb or in the office with compressed air or oxygen. There are several small compression machines suitable for home or office use.

Dr Prigal uses a plastic box about 12 inches (30.5 cm) in all dimensions with a nebulizer inserted into its back wall and the face mask connected with its front wall. Pressure is supplied by a steam kettle heated electrically and attached to the nebulizer. The aerosol is nebulized into the box and is breathed in by the patient through the face mask.

Drs Krasno and Mary Karp have been demonstrating a small plastic apparatus with either mouth or nose attachments. A cartridge of 100,000 units of penicillin is inserted, and as the patient breathes in, a little metal ball hits the cartridge and shakes a little penicillin dust into the floor of the apparatus. This is inhaled into either the nose or the mouth. On exhalation the apparatus is removed from the nose or the mouth so as not to blow moist air onto the cartridge of penicillin. A little sulfanilamide powder is mixed with the penicillin in the cartridge to make easier flowing. The main objection of my patients who have used this apparatus is that the penicillin does not shake out of the cartridge at times. It is a clever apparatus.

A little plastic canopy can be used with infants and small children. It fits over the head and has a special nebulizer which attaches to the top. The patient lies down for the treatment, and this can be used in office, hospital or home.

I wish to mention again the boy with sinusitis and bilateral mastoiditis to confirm what Dr Barach said about the value of penicillin aerosol in chronic sinusitis. This boy, 14 years of age, had pansinusitis and bilateral otitis media, one side had to be operated on for acute mastoiditis. The ears continued to drain in spite of nasal treatment, removal of adenoids and tonsils and injections of penicillin. After one week of inhalations of penicillin, without any other therapy, the condition cleared up entirely. It sounds a little spectacular, but many patients have responded in just such a manner.

ROLE OF COMPENSATORY HYPERTROPHY AND SIMPLE ATROPHY IN INTRANASAL SURGERY

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THE PURPOSE of this paper is to report a method of changing the aerodynamics of the nose through intranasal surgical procedures, in a specific manner, so as to initiate spontaneous reactions of the nasal tissue and thus release the compensatory forces of hypertrophy and simple atrophy which will finally restore normal physiologic processes. These forces are basic nasal compensatory mechanisms and are essential for physiologic restoration and control. The surgical technic described is based on the fundamental laws of the aerodynamic physics of the nose, which is a bilaterally symmetric organ dependent on these laws for physiologic activity. The cases presented were selected from those of a diversified group of patients of different ages to demonstrate that the spontaneous reactions initiated can be controlled over a period of time until the normal physiology is reestablished.

A brief review of the accepted functions and anatomic structure of the nose will serve as a basis for describing the surgical methods used by me in actual practice. First, the functions are considered, and then the structure on which these functions are superimposed to form the fundamental physiologic and anatomic pattern of the nasal compensatory area involved.

The functions of the nose are classified, usually, as respiratory, phonatory, olfactory, gustatory, and also ventilatory, which includes the ventilation of the nasal accessory sinuses and eustachian tubes. Maintenance of organic structure may be added as another function according to Haldane,¹ who has stated "The assumption of the existence of organic regulation to both structure and function is absolutely fundamental."

Generally, from a surgical point of view, it is believed that two of the most important factors contributing to nasal health and comfort are adequate ventilation and drainage. However, after surgical intervention has established what appears to be adequate ventilation and drainage, numerous symptoms remain, and not infrequently others have developed.

¹ Haldane, J. S. *The New Physiology and Other Addresses*, Philadelphia, J. B. Lippincott Company, 1919, p. 89.

Consequently, accompanying any basic change in nasal structure there must be a corresponding change in function. As Machs says, "In every symmetrical system every deformation that tends to destroy the symmetry is complemented by an equal and opposite deformation that tends to restore it"² Proetz has pointed out that "in the nose, structure plays a fundamental part in the proper maintenance of physiologic air channels, streams and pressures, in the humidification of the air and in the conditioning of the nose itself"³

The anatomic structure of the nose is characterized by bilateral symmetry and consists of two nasal chambers bounded by a roof, a floor, a single mesial wall (septum nasi) and two lateral walls, the vestibules lined with mucous membrane, and three turbinate bodies covered with mucous membrane located on each lateral wall. "The two nasal chambers are more or less regular spaces, triangular in shape, situated on either side of the middle line of the face, extending from the base of the cranium to the roof of the mouth, and separated from each other by a thin vertical septum"⁴ They communicate with the frontal, ethmoid, sphenoid and maxillary sinuses, and for all practical purposes are the continuation of the eustachian tubes. The vestibule is just within the anterior naris and is bounded on the median side by the soft tissues of the nose. The superior, middle and inferior turbinate bodies are covered with mucous membrane containing venous plexuses, known as "swell bodies," with the inferior turbinate bodies containing the larger number. The turbinate bodies are nearly parallel and approximately an equal distance from each other, subdividing the nasal passages into three channels called superior, middle and inferior meatuses.

The nasal septum consists mainly of the anterior triangular cartilage and the perpendicular plate of the ethmoid and the vomer, which are bony in structure. It is covered on both sides with mucous membrane and not only divides the two nasal chambers but acts as a rigid wall to make definite spacing when the turbinate bodies expand or contract to narrow or enlarge the chambers according to the atmospheric changes. The importance of the rigidity of this structural pattern has been emphasized by Pratt,⁴ who stated "If we are to obtain the utmost use of the nose, the septum must be straight, thin and in the middle line and the turbinates of normal size and in place, thus an equal amount of work, in modifying the air as it passes through, is performed by the two nasal chambers" (fig 1)

2 Mach, E. *Science of Mechanics*, translated by T. J. McCormack, Chicago, Open Court Publishing Company, 1902, p. 395.

3 Proetz, A. W. *Essays on the Applied Physiology of the Nose*, St. Louis, Annals Pub. Co., 1941, p. 30.

4 Pratt, F. J., and Pratt, J. A. *Intranasal Surgery*, Philadelphia, F. A. Davis Company, 1924.

When the bilateral symmetry of the nose is disturbed—that is, when for some reason the air flow is not equal between the two sides—a spontaneous biophysical reaction occurs which tends to restore the aerodynamic balance and equalizes the air flow between the two nasal chambers. Aerodynamically, the nose itself responds to any interference with its functioning as a balanced unit. This physiologic response may not provide better ventilation or better drainage, but always tends to maintain integrity of structure, or the aerodynamic balance of a bilateral structure.

Thus when the septum becomes deviated in any degree to either side, the air flow on the deviated, or convex, side is reduced by reason of the narrower space and the air flow on the opposite side is greater on account of the wider space on this side. Nature then proceeds to reduce the

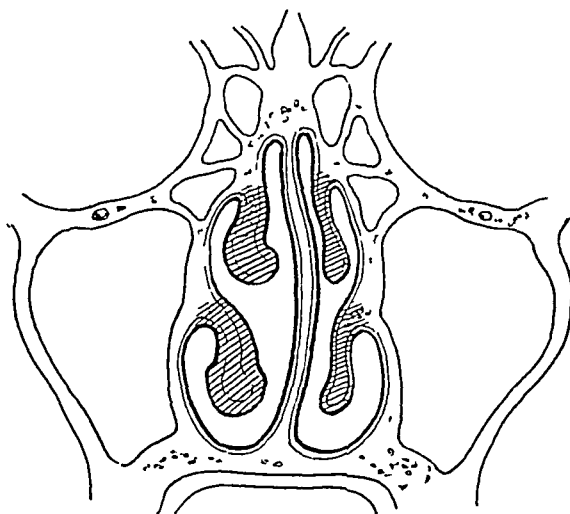


Fig 1—Diagrammatic cross section of the normal nose

lumen on the wider concave side by enlarging the tubinate bodies and the other structures in an effort to restore the aerodynamic balance through so-called compensatory hypertrophy or “space-filling” reaction of the turbinates, at the same time a limited amount of space is gained on the convex side through simple atrophy or “shrinking” reaction (fig 2). Compensatory hypertrophy and atrophy in the nose have been recognized and described by Pratt,⁵ Jackson and Coates⁶ and Morrison.⁷

5 “Deflected septa and ‘spurs’ on the septum make the nasal chambers unequal in size so that more air passes through one side than the other. Nature, in attempting to equalize the air space enlarges the turbinates by hypertrophies or hyperplasia on the concave side of the deflection. Large volumes of air, together with the dust and dirt passing through the concave side, create a congestion in the turbinates on this side, which, after a time, produce a hypertrophy

These reactions of "space-filling" and "shrinking" can be understood in relation to maintaining integrity of structure, a basic reaction of the organ itself, but they are not easily explained as a therapeutic measure because of the limitation of spatial capacity, which makes better ventilation and drainage more difficult

The surgical technic described is based on the assumption that the physiologic reactions of compensatory hypertrophy and simple atrophy are basic organic forces which can be partially controlled and directed over a period of time. The control of these organic forces, initiated through intranasal surgical procedures in the compensatory area of the nose, is established by artificial changes in the aerodynamic balance of the nose because, according to Thompson, "no organic form exists except as is in conformity with physical and mathematical laws" ⁸

Formerly, in a surgical case of deviated or obstructive septum with compensatory changes of the turbinate bodies and surrounding structures, either the submucous resection operation was used or the enlarged middle turbinate body was partly or totally removed (fig 3). The submucous resection operation included removal of the greater portion of the cartilaginous and bony partition, leaving only the mucous membrane or "flap" to separate the two nasal passages. This residual partition is not rigid but is very much like a flexible diaphragm susceptible to movement back and forth by the air currents on either side in the process of breathing (fig 4). With compensatory hypertrophy or thickening of the tissue and other structures in one side of the nose and with simple atrophy or thinning on the opposite side, this flexible partition moves to either side to accommodate the air flow, and, consequently, the nose is unable to control the air currents aerodynamically

of the turbinates and so narrows the space. (It is a compensatory hypertrophy.) On the convex side the deflected septum presses on the turbinates, and nature tries to readjust the turbinates to make an adequate air space. As only a small volume of air can pass through, very little irritation is produced. The mucous membrane is thinned, which means a lessened blood supply, and in some cases even the bony part of the turbinate is reduced in size. (It is a compensatory atrophy.)" (Pratt and Pratt,⁴ pp 39-40)

6 "Septal spurs and deviations are frequently accompanied by hypertrophy of the turbinal tissue in the wider naris. This is a compensatory hypertrophy and often is not pathologic" (hypertrophic rhinitis) (Jackson, C., Coates, G. M. and Jackson, C. L. *Nose, Throat and Ear and Their Diseases*, Philadelphia, W. B. Saunders Company, 1929, p 49)

7 "Hypertrophy of the mucosa and bone of the turbinates is seen with deviations of the septum of long standing, the middle and inferior turbinates on the wide side of the nose enlarge to compensate for the abnormal width of the air passage" (chronic rhinitis) (Morrison, W. W. *Diseases of the Nose, Throat and Ear*, Philadelphia, W. B. Saunders Company, 1938, p 89)

8 Clark, W. E. Le G., and Medawar, P. B. *Essays on Growth and Form Presented to D'Arcy Wentworth Thompson*, London, Oxford University Press, 1945, pp 15-16

in order to utilize this compensatory mechanism, or primary basic reaction. The natural organic regulation of the nose being no longer operative or effective, a spontaneous physiologic adaptation or adjustment which may be "advantageous but not designed" is initiated as a secondary basic reaction, becoming responsible for many of the pathologic variations in chronic nasal symptomatology.

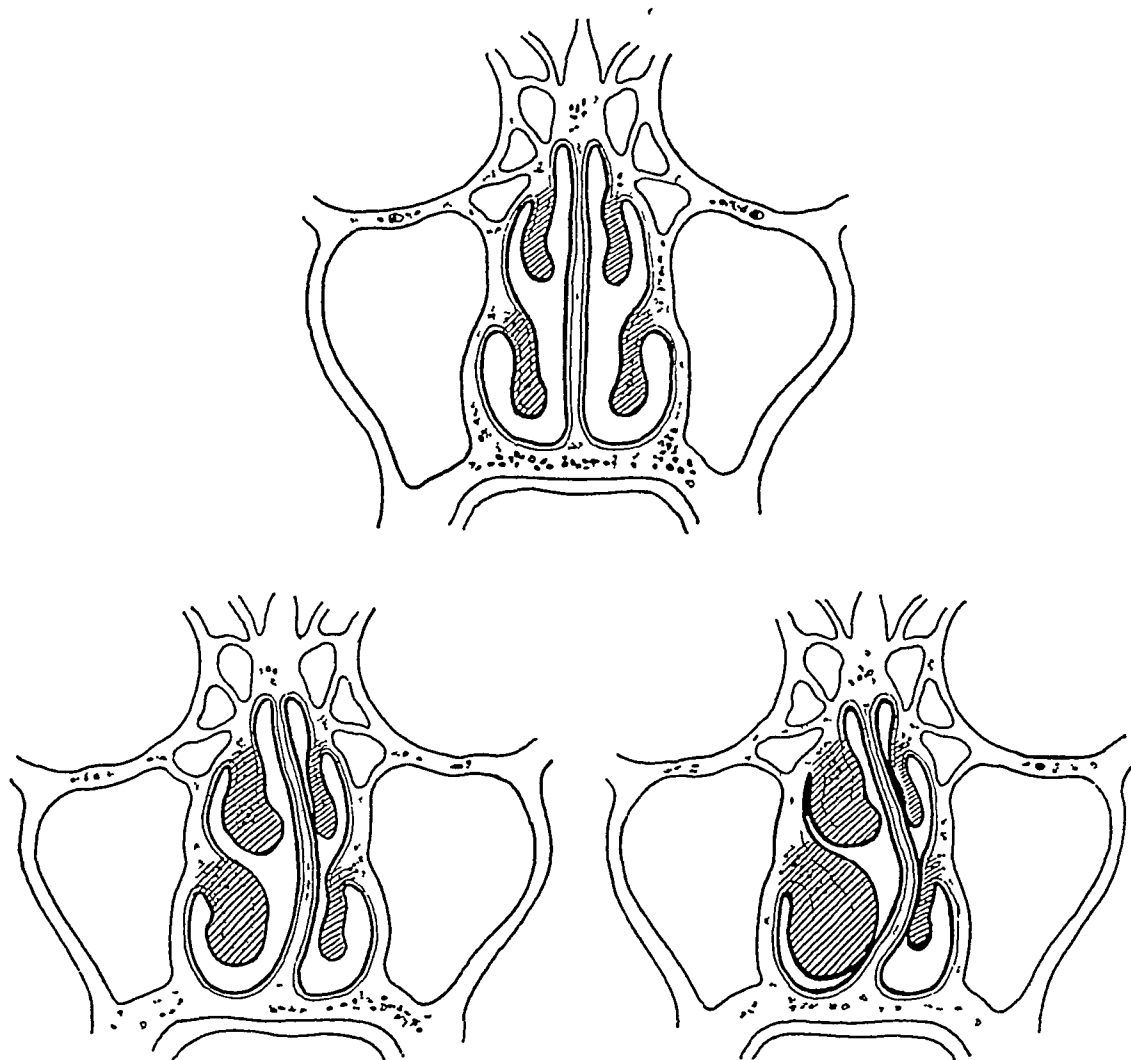


Fig 2—Progressive stages of compensatory changes occurring in deviation of the septum

When the enlarged middle (or compensatory) turbinate body is partially or completely removed, the inferior turbinate body and the remaining structures continue the compensatory reaction by thickening and filling in most of the space previously occupied by the middle turbinate body (fig 5).

The following corrective surgical technic, which I developed, is based on a biomechanical approach and requires that the maximum

structural rigidity of the septum be preserved. The septum must be moved over as nearly intact as possible into the concave side for the purpose of crowding the hypertrophied structures. This procedure is accomplished by separating part of the septum along the floor of the nasal chambers (from before backward), so that it can be mobilized

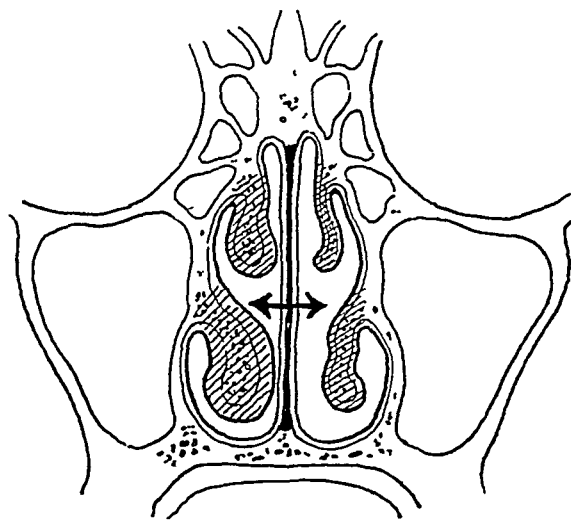


Fig 3—Diagrammatic cross section of deviated septum with compensatory changes in the turbinate bodies

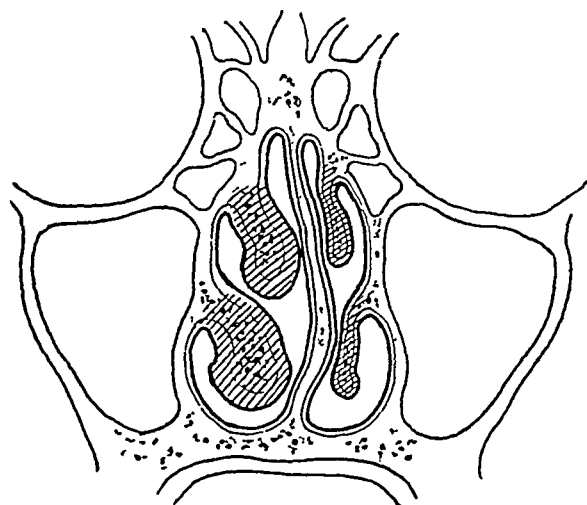


Fig 4—Diagrammatic cross section of a submucous "flap"

and forced over toward the nasal midline (figs 6 and 7). A "submucous" incision is made as near the base of the septum as feasible, and the minimum amount of cartilaginous and bony structure necessary to effect mobilization and realignment is removed. The septum, now somewhat movable at its base, is fractured and forced toward the nasal midline with the "special" elevator illustrated in figure 8. The enlarged

and hypertrophied inferior turbinate body, present in most cases, should be fractured outward before one proceeds with the straightening of the septum (figs 9 and 10)

A Simpson splint, of suitable size and shape, covered with dental wax, is inserted to hold the structures in their new position. Approxi-

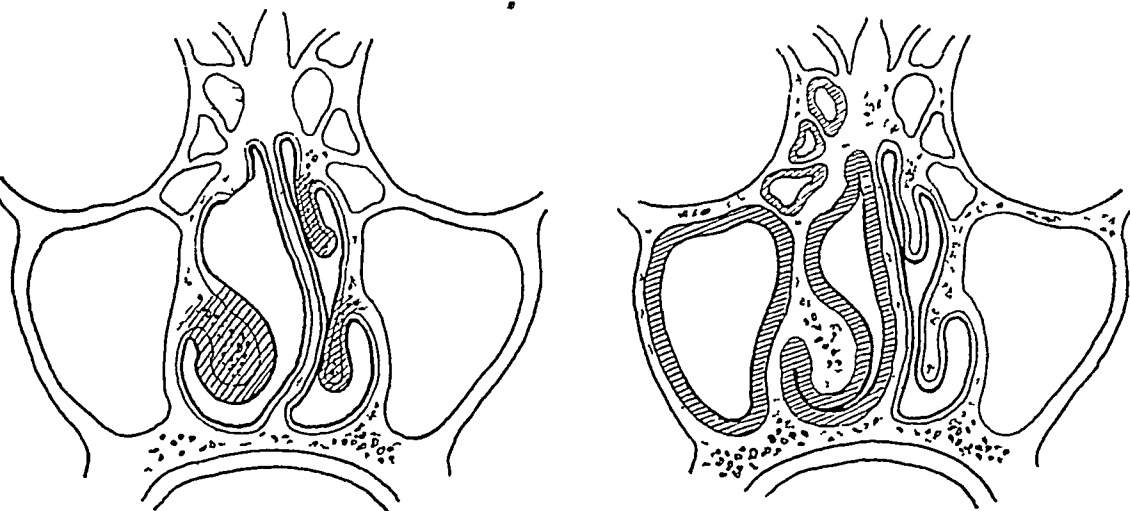


Fig 5—Diagrammatic cross sections showing (*left*) the middle turbinate body removed and (*right*) compensatory changes in the inferior turbinate body and other structures

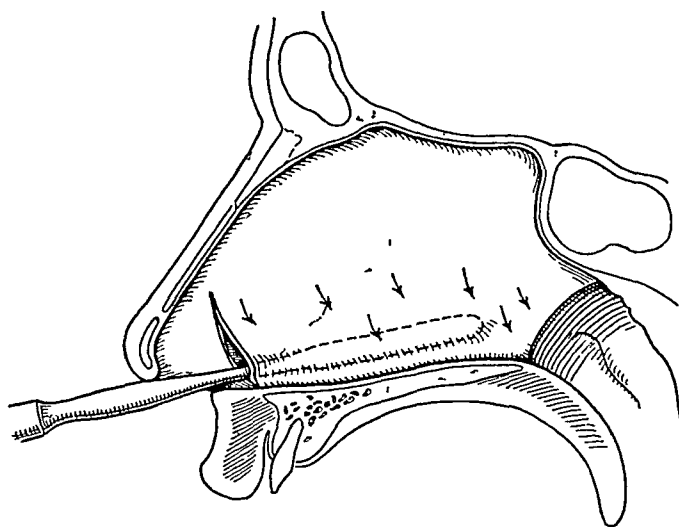


Fig 6—Elevation of the membrane along the floor with the Freer elevator

mately twenty-four hours later the splint is removed, no packing is necessary. Some modification of these procedures must be considered in each individual case because of variations in anatomic contour. In actual practice the compensatory area of each nose must be redesigned

according to a definite long range plan in order to obtain permanent results

In a typical case, after the operation or manipulation described, the septum should be in position in the nasal midline, the bilateral symmetry partly restored and the air flow controlled so that it can approach equalization on the two sides. A reduction of the thickened tissues and

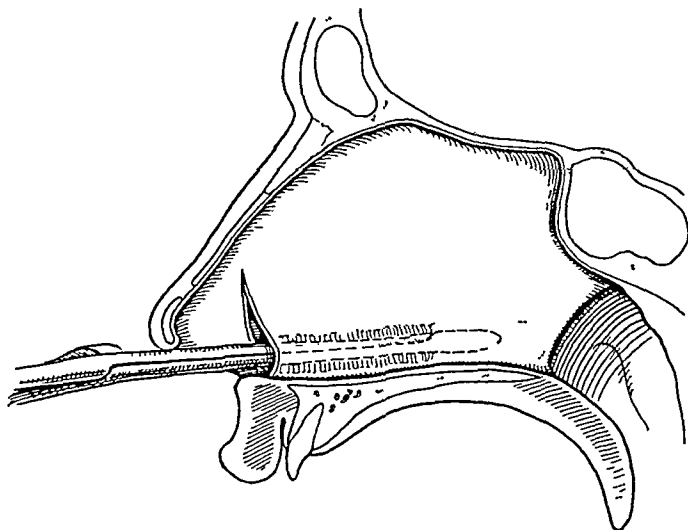


Fig 7—Release of the septum along the floor with a bone forceps

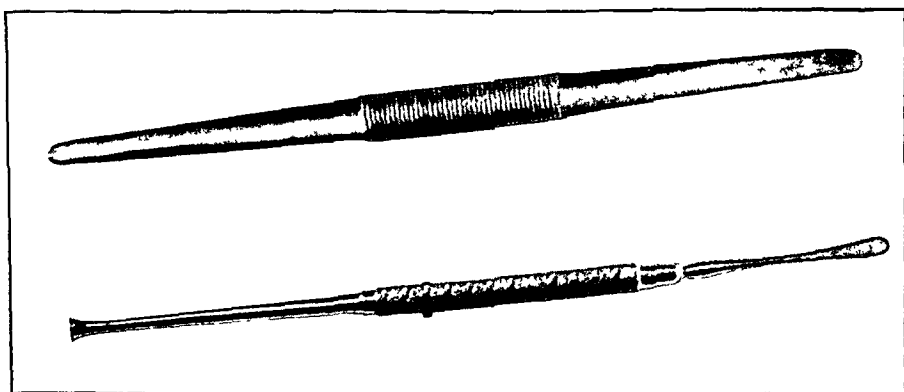


Fig 8—"Special" elevator above, Freer elevator below

other structures on the concave side now begins to take place, the thinned-out tissues of the convex side begin to be restored to normal thickness and at the same time normal physiologic functioning is being reestablished. This result has been accomplished by making "biomechanical" structural changes and by using the forces of compensatory hypertrophy and simple atrophy but in exactly the reverse order from that used by nature before the operation (fig 11). These forces and

reactions, which have been initiated surgically, are self limited and follow a definite biophysical pattern. The time required for clinical recovery varies from a few days to several weeks. This is followed by the gradual return of the tissues to normal, which may continue over a period of

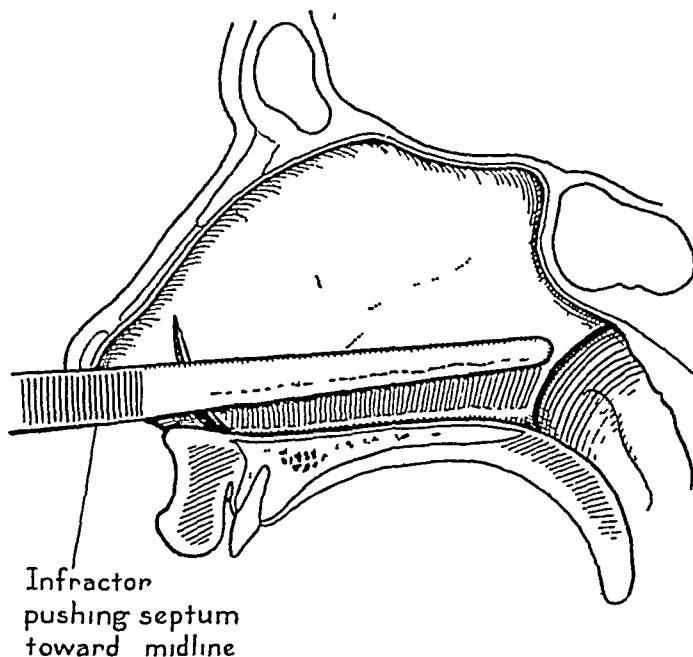


Fig 9—Use of elevator in realinement of the septum

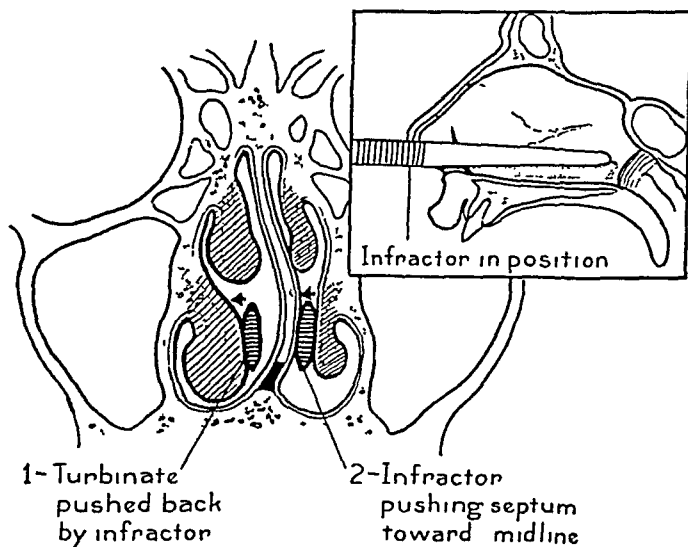


Fig 10—Diagrammatic cross section showing the elevator fracturing the septum and turbinate body

months to several years, depending on each individual case. The application of these principles to chronic nasal obstruction in any age group presents new aspects in the field of preventive medicine.

The surgical technic described was used in the following selected types of cases (1) systemic absorption, (2) chronic "sinus" headache, (3) reflex referred pain, (4) systemic absorption with chronic "sinus" headache, (5) allergic type with hay fever and asthma, (6) narrow and obstructive nasal passages, in (A) a child and (B) an adult, (7) deafness, catarrhal type, (8) deafness, combined type, and (9) deafness, purulent otitis media type. A tabulation of reported cases as well

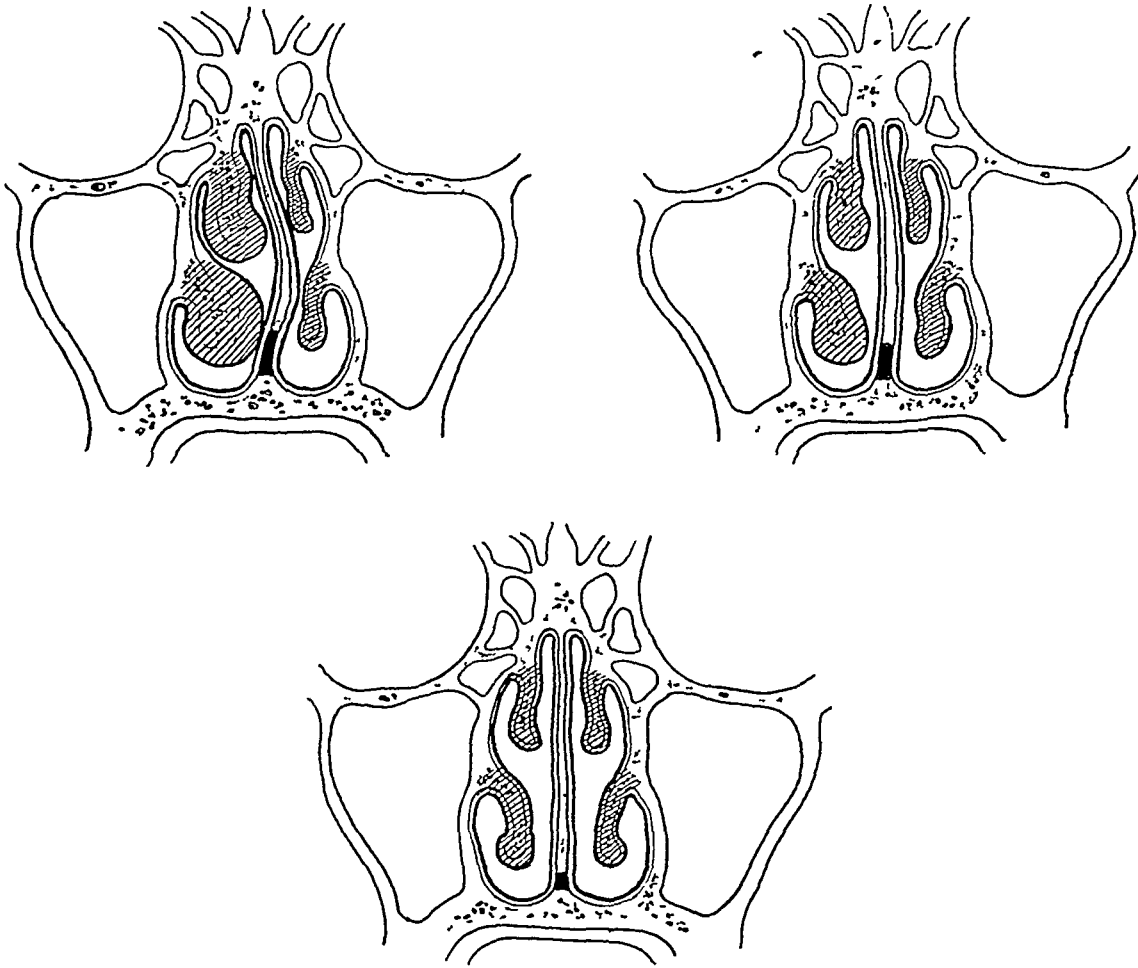


Fig 11—Diagrammatic cross section of typical deviated septum with compensatory changes in turbinate bodies, showing stages of septal realignment

as a brief summary of each case is presented, including a description of the surgical technic

REPORT OF CASES

CASE 1—*Systemic absorption type, chronic rhinosinusitis with polypoid degeneration and deviated septum with spur formation*

H T R, a man aged 39, was first seen Feb 6, 1939, with chief complaints of generalized headache, pain in the regions of the frontal and maxillary sinuses, profuse nasal discharge, difficulty in breathing through the nose, sore throat, with

pain on swallowing, hoarseness, cough and general malaise. He gave a history of frequent attacks of similar nature, usually lasting six to eight weeks and more frequent in winter, for a period of years, general fatigue, poor appetite and rheumatic-like pain in the back and shoulder, he was 15 pounds (6.8 Kg) underweight and both mentally and physically sluggish. He had been given a great deal of "sinus treatment," and a Caldwell-Luc operation had been advised.

Summary of Reported Cases

Case No	Type	Sex and Age	Period of Observation	Physical Findings	Date of Operation	Result
1	Chronic rhino sinusitis	Male, 39	2/ 6/39 to 5/15/47	Deviated septum, spur formation, polypoid degeneration, compensatory changes	6/30/39	6/30/40 Weight normal, free from nasal symptoms, tissues normal in color and general appearance to 5/15/47
2	Chronic "sinus" headache	Female, 32	2/26/44 to 3/15/47	Deviated septum, spur formation, compensatory changes	5/ 1/44	6/1/44 Free from symptoms, no recurrence to 3/15/47
3	Chronic rhino sinusitis, referred pain	Female, 39	1/17/44 to 12/22/46	Deviated septum, spur formation, compensatory changes, generalized hypertrophy	1/18/44	5/18/44, Entirely recovered, no recurrence to 12/22/46
4	Chronic "sinus" headache, nasal obstruction	Male, 43	6/11/40 to 9/ 6/47	Postoperative sub mucous resection	6/11/40	6/11/41 Entirely recovered no recurrence to 9/6/47
5	"Allergic type", hay fever and asthma	Female, 41	12/10/42 to 11/20/47	Deviated septum, polypoid degeneration, compensatory changes	1/ 6/43	11/20/47 Free from nasal and "allergic" symptoms
6A	Nasal obstruction in child	Male, 8	1/25/41 to 6/ 5/47	Deviated septum	9/16/41	6/5/47 Free from symptoms, minor septal deformity
6B	Nasal obstruction	Female, 21	1/ 7/43 to 12/28/43	Deviated septum, compensatory changes	1/ 1/43	12/28/43 Free from nasal symptoms
7	Deafness catarrhal type	Female, 19	10/14/41 to 10/13/44	Deviated septum, spur formation, compensatory changes	10/18/41	10/13/44 Normal hearing (both ears)
8	Deafness, combined type	Male, 43	7/25/41 to 4/ 6/47	Deviated septum, compensatory generalized hypertrophy	7/28/41	4/6/47 20 decibel recovery, 10 decibel loss remains
9	Deafness, chronic purulent otitis media type	Male, 28	7/30/43 to 8/ 8/45	Deviated septum, compensatory changes	8/ 9/43	8/8/45 Audiogram 15 decibel gain right ear 15 to 20 decibel gain left ear, 5/17/46, hearing gain maintained

On examination no external deformity of the nose was evident. The septum was deviated to the left, with spur formation along the ridge of the vomer on the left side, this spur made contact with the left inferior turbinate body, which was irregular and large. The left middle turbinate body was crowded and larger than the one on the right. The right inferior and middle turbinate bodies showed considerable compensatory enlargement. A large polypus lay behind the spur in the left middle meatus. There was moderate generalized congestion of the nasal mucosa throughout, with some increase of mucoid secretion, but purulent material was not noted. Transillumination of the frontal and maxillary sinuses revealed them to be fairly clear and evenly illuminated. The tonsils had been

removed. There was considerable granulation tissue along the lateral folds on both sides of the posterior pharyngeal wall.

Local and general treatment was given until the acute condition had subsided. Operation was performed on June 30, with the area under local anesthesia. By means of a modified submucous resection the nasal spur was removed and the remaining bony and cartilaginous portions of the septum were fractured toward the nasal midline (to the right) and the right inferior turbinate body was fractured sharply throughout its entire length. The right middle turbinate body was "notched" with a Gruenwald punch forceps at the most bulbous anterior inferior portion. The polypus was removed from the left middle meatus with the electrocoagulation snare. A single Simpson splint covered with dental wax was inserted into the left inferior meatus to hold the septum in its new position for the first twenty-four hours.

On follow-up one year after operation, the patient had regained his normal weight and was free from all respiratory symptoms. The rheumatic pains were gone, and the general health was good. When last seen, Feb 15, 1946, the patient had had no recurrence of symptoms and the tissues were normal in color and general appearance.

CASE 2—Chronic sinus headache type, chronic rhinosinusitis, chronic nasal obstruction

V W M, a woman aged 32, was first seen on Jan 26, 1944. The chief complaint was headache in the frontal area and in the bridge of the nose, radiating to the top and back of the head. She had had frequent colds, one about every six weeks during the year and three during the preceding winter. Additional complaints were of difficulty in breathing through the nose, excessive nasal discharge, feeling of generalized fatigue, sluggishness and mental dulness. She gave a history of nasal symptoms extending back to childhood, she had always had many colds and a great deal of "sinus" treatment. Examination revealed no external deformity of the nose. The septum was deviated to the right, and the deformed septum made contact with the right inferior turbinate body. There was slight simple atrophy of the right middle and inferior turbinate bodies, accompanied with compensatory hypertrophy of the left middle and inferior turbinate bodies, together with generalized congestion of the nasal mucosa and increased mucoid secretion. The tonsils had been removed. On objective examination the ears were normal.

By means of a modified submucous resection, done on May 1 with the area under local anesthesia, a septal spur was removed and the remaining bony and cartilaginous portions of the septum were fractured toward the nasal midline (left), and the left inferior turbinate body was fractured outward throughout its entire length.

On follow-up it was learned that the patient had been free from symptoms of headache at the end of one month and since then she has had no further history of colds. When she was last seen, on March 15, 1947, the septum was in the nasal midline, and the mucous membrane was normal in appearance.

CASE 3—Reflex referred pain type, chronic rhinosinusitis with deviated septum with spur formation

L J, a 39 year old woman, was first seen on Jan 17, 1944 reporting the chief complaint of generalized headache with pain in both frontal areas radiating to the top and back of the head and also down the back of the neck into the shoulders. Further complaints were of frequent colds, difficulty in breathing through the nose, excessive nasal discharge, general fatigue, some loss of weight and a sluggish feeling. These symptoms extended back eight years. The patient

had had a great deal of "sinus" treatment. Her teeth had been examined and found normal. Glasses had been prescribed, but they did not relieve the headache. She had been told that she had hay fever, but she had had no tests for allergy. Although examination revealed no external deformity of the nose, the septum was deviated to the left, with spur formation along the ridge of the vomer on the left side. There was compensatory enlargement of the right middle and inferior turbinate bodies, some atrophy of the left middle turbinate body and moderate generalized congestion of the mucous membrane, with considerable increase of mucoid secretion. Transillumination of the frontal and maxillary sinuses showed them to be fairly clear and evenly illuminated. The tonsils had been removed. There was a moderate amount of postnasal discharge adhering to the posterior pharyngeal wall. Objective examination of the ears showed no abnormality except slight retraction of each tympanic membrane. Audiometric examination revealed about a 10 decibel loss of hearing by air conduction in low registers in the right ear and about a 15 decibel loss in approximately the same frequency in the left ear.

At operation, Jan 18, 1944, done with the area under local anesthesia, the septal spur was removed by means of a modified submucous resection, the remaining bony and cartilaginous portions of the septum were fractured toward the nasal midline (right) and the right turbinate body was fractured sharply outward throughout its entire length. The patient was free from most symptoms at the end of one month, and there was continued improvement without further treatment until Dec 22, 1946, when the tissues appeared normal.

CASE 4—*Systemic absorption and chronic "sinus" headache type, chronic rhinosinusitis with septal absorption*

W C, a man aged 43, was first seen on June 11, 1940, complaining of dull heavy headaches on the left side of the face in the region of the antrum. He stated that his eyes felt sensitive, there was generalized fatigue of the eyes and impaired "sinus drainage." The history revealed that the present condition had begun twelve years previously with an attack of influenza. He had nasal treatment four times a week for many months. He had had a double antrotomy in 1930 and an operation on the septum in 1933, after which he was advised that further operations would not help. He gave a history of frequent colds, his head always felt dull, and it had been difficult for him to work. He was sensitive to drafts, winds and air-conditioned rooms, he had lost 25 pounds (11.3 Kg) in weight, had a poor appetite, slept poorly and complained of general fatigue. There was no external deformity of the nose. The septum was markedly to the left, with spur formation along the ridge of the vomer making contact with the middle and posterior thirds of the left inferior turbinate body. There was moderate compensatory enlargement of the right middle and inferior turbinate bodies and some enlargement of the anterior portion of the left inferior turbinate body. A small amount of the inferior border of the anterior tip of both inferior turbinate bodies had been removed at the time of the antrotomy. The openings into both antrums were patent. Partial submucous resection of the septum had been done and part of the triangular cartilage removed. The tonsils had been removed. The ears were found to be normal on objective examination.

Operation was done on the same day, with the area under local anesthesia. By means of a modified submucous resection a revision of the septal operation was done, with removal of the septal spur (left) and the remaining bony and cartilaginous portions of the septum were fractured toward the nasal midline (right) and the right inferior turbinate body was fractured sharply outward throughout its entire length.

Six weeks later there was pronounced symptomatic improvement, with reduced discharge. The patient was gaining weight. On May 6, 1941, there was complete recovery, and there was no recurrence of symptoms up to Sept 6, 1947, when the nasal tissues appeared normal.

CASE 5—Allergic type with hay fever and asthma, pronounced deviation of the septum with compensatory changes in the turbinate bodies, with polypoid degeneration

S. M., a married woman aged 41, was first seen on Dec 10, 1942. The chief complaint was of a "stuffed-up" nose and a feeling of pressure in the nasal regions and ears. In addition, she complained of sneezing attacks, watery discharge from the nose, loss of the sense of smell and loss of head resonance in the voice. Frequent colds had kept her away from work three to five days each month. She was subject to "hay-fever-like" attacks throughout the year, which were worse in summer. She had also had localized attacks of swelling about the face—the half of the upper lip—or of the tissues about one side of her face or about one or both eyes (angioneurotic edema). She complained that she felt tired all the time, did not sleep well, lacked energy, felt mentally dull and believed that her thinking was impaired. She also had asthmatic-like attacks. She gave a history of trouble with the nose since childhood, frequent colds, "stuffy" and "runny" nose, sneezing and coughing. She had had some sort of intranasal operation in childhood, and polypi were removed two years before the present examination. She had had a number of allergic tests with negative results, local nasal treatments had been given over a period of years, but her condition had gradually grown worse. Examination of the nose revealed a slight deviation of the lower portion of the nasal pyramid to the left of the facial midline. The alae were not well dilated, the vestibules are clear. The septum was deviated markedly to the left, so that it almost completely blocked ventilation on that side. A pronounced spur formation along the vomer made contact with the left inferior turbinate body. The left middle and inferior turbinate bodies were somewhat small and atrophied. The right nasal cavity was very much widened because the concavity of the septum was on this side. The right middle turbinate body was greatly enlarged, extending well beyond the nasal midline to the left and making contact with both the nasal lateral wall and the septum. The right inferior turbinate body was greatly enlarged and extended into the septal cavity well beyond the nasal midline. There were several polypi in the right middle meatus. Transillumination of the frontal and maxillary sinuses showed them to be fairly clear and equally illuminated. The tonsils had been removed. Objective examination of the ears showed a slight thickening of each tympanic membrane. An audiogram taken December 12 showed loss of perception of the higher frequencies, beginning at 512 and reaching a loss of 30 decibels at 8,192.

Operation was done Jan 6, 1943 with the area under local anesthesia. The polypi were removed by the electrocoagulation snare. The mesial half of the left middle turbinate body was removed and the remaining portion fractured outward. The inferior turbinate body was fractured outward along its posterior two thirds. By means of a modified submucous resection, the septum was separated along the base, the spur removed and the remaining cartilaginous and bony portion fractured toward the nasal midline (right) and held in this position by means of a Simpson splint covered with dental wax. On Dec 14, 1943, two small polypi were removed from the right middle meatus, the right inferior turbinate body was fractured further outward and the septum was again fractured toward the nasal midline. A audiogram taken on December 15 showed normal hearing in

the left ear and considerable improvement in the right ear, except for the 8,192 frequency. On June 7, 1944, the septum was fractured more closely to the nasal midline (right) and right turbinate body fractured farther outward.

On Nov 5, 1945 the patient reported that she had been free from symptoms for the past six months, and on May 10, 1946 she was still improving. When she was last seen, on Nov 20, 1947, the septum was in the nasal midline and the nasal mucosa was almost normal in appearance. There were no polyps. She had recovered the sense of smell and was completely free from all allergic symptoms.

CASE 6 A—*Narrow and obstructive nasal passages in a child*

J H, a boy aged 8, was first seen on Jan 25, 1941. The chief complaint was of frequent colds and stuffy nose, excess purulent discharge, obstructive nasal breathing "sinus attacks," headache, failure to gain weight, poor appetite and generalized fatigue. The present condition had existed for three years but had become worse during the preceding year. Examination of the nose showed rather pronounced deviation of the septum to the right, with almost complete obstruction to ventilation on this side. There was some compensatory hypertrophy of the left middle and inferior turbinate bodies. Generalized congestion of the nasal mucous membrane was accompanied with increased mucoid secretion. The tonsils were present, there was slight injection of peritonsillar tissues. On objective examination of the ears revealed nothing abnormal.

Operation (manipulation only) was done on Sept 16, 1941, with the patient under general anesthesia. By means of manipulation only, the septum was fractured (with an Asch forceps), mobilized and placed toward the nasal midline (left) by means of the special elevator. A Simpson splint covered with dental wax was inserted into the right nasal passage and removed in twenty-four hours. Recovery was uneventful.

When seen on follow-up Aug 25, 1945, the boy had had no further treatment and had been free from symptoms since operation. Examination of nose still showed slight deviation of the septum to the right, freedom from discharge, adequate ventilation and color and condition of the membrane within normal limits. On April 2, 1946, he was free from nasal symptoms and there had been no change in physical findings. When last seen, on June 5, 1947, he had continued free from all symptoms and only the minor septal deformity remained.

CASE 6 B—*Narrow and obstructive nasal passages in an adult, chronic rhinosinusitis*

J K, a woman aged 21, was first seen on Jan 7, 1943, complaining of frequent colds with stuffy nose, excessive postnasal discharge and attacks of laryngitis and hoarseness which interfered with her occupation as singer. The present condition had existed for four or five years, becoming worse during the preceding year. Examination of the nose revealed moderate deviation of the nasal septum, especially in the posterior inferior third. There was some compensatory hypertrophy of the right inferior turbinate body throughout its entire length, the left inferior turbinate body was somewhat enlarged in its anterior two thirds. There was a great deal of mucoid discharge, especially in the inferior meatus on each side. Transillumination of the frontal and maxillary sinuses showed them to be fairly clear and equally illuminated. The tonsils had been removed. There was a moderate amount of granular tissue in each tonsillar fossa, together with some granulation along lateral folds on either side. Objective examination of the ears revealed no abnormalities. Operation (manipulation) was done on

Jan 1, 1943, with the area under local anesthesia. By means of manipulation both inferior turbinate bodies were fractured outward and the posterior third of the septum was fractured toward the nasal midline (right). At the same time pharyngeal granulations were removed by electrocoagulation. At follow-up on Dec 29, 1943, the patient was completely free from previous respiratory symptoms and reported no colds since the operation. The septum was in the nasal midline. There was slight generalized congestion of the nasal mucous membrane.

CASE 7—Deafness, catarrhal type, deviated and obstructive septum with hypertrophic rhinitis and bilateral chronic catarrhal otitis media

N S, a woman aged 19, was first seen on Oct 14, 1941, complaining of impaired hearing in both ears, frequent colds and "sinus" attacks. She had first noticed loss of hearing in 1938 while she was in school, and the condition had been gradually getting worse since then. She had had frequent colds since infancy. The tonsils had been removed at the age of 3 years. Local nasal treatment for "sinus" trouble had been given over a period of years. The patient's mother had for many years had impaired hearing of unknown cause. Examination of the nose revealed a very slight external deformity of the nasal bridge, a result of an old trauma, moderate deflection of the septum to the left, with spur formation along the ridge of the vomer, compensatory enlargement of the right middle and inferior turbinate bodies, and thickening and congestion of the entire nasal mucous membrane. Transillumination of the frontal and maxillary sinuses showed them to be fairly clear and equally illuminated. The tonsils had been removed. There was a small amount of granulation at the base of the left tonsillar fossa. The tympanic membranes were intact but moderately retracted. Audiometric examination showed a 40 decibel loss of hearing for low tones in the left ear and a 20 decibel loss in the right ear.

Operation was done in Oct 18, 1941, with the area under local anesthesia. By means of a modified submucous resection the nasal spur was removed and the remaining bony and cartilaginous portions of the septum were fractured toward the nasal midline (right), both inferior turbinate bodies were fractured outward.

Audiometric examination on March 19, 1942, five months after the operation, showed improvement in hearing, especially in the left ear with no loss for any tone falling below the 20 decibel level. On Oct 21, 1942, one year after the operation, hearing in both ears was at approximately normal levels. On Oct 14, 1944, hearing was normal in both ears. The septum was in the nasal midline, and the nasal mucosa was normal in appearance.

CASE 8—Deafness, combined type, chronic rhinosinusitis, deviated septum with spur formation

J F, a man aged 43, was first seen on July 25, 1941. His chief complaint was of impaired hearing in both ears, more pronounced on the left, with buzzing and ringing sounds in the head and a sensation of fullness and pressure in the ears. The condition had been of very gradual onset, it dated back five or six years but it was becoming worse and was beginning to interfere with his occupation as waiter. A moderate postnasal discharge of clear mucoid material was noted. The history revealed no involvement of the ears immediately preceding the present condition or in childhood. The patient had never had an aural discharge and did not remember having earache. He had had two or three "colds" each year, but they cleared spontaneously in a week to ten days without headache or "sinus" complications. The tonsils had been removed five years previously, and the patient had had fewer colds since then. There was no external deformity of the nose. The vestibules were open and well formed. There was some deflection of the septum to the left especially in the middle and posterior third. A sharp spurlike formation in the

region of the posterior third of the septum made contact with the posterior third of the left middle turbinate body. The right naris was free from bony obstruction, and the septum showed slight concavity on this side in the middle and posterior portions. There was some compensatory enlargement of the middle and inferior turbinate bodies into the concavity. The nasal mucosa was moderately congested throughout, with more thickening on the right side than on the left. There was a pronounced increase in mucoid secretion, especially in the inferior meatuses. Transillumination of the frontal and maxillary sinuses revealed slightly diminished but equal illumination. The tonsils had been removed. Objective examination of the ears showed the external canals free from deformity or obstruction. The tympanic membranes were intact, and there was no evidence of recent inflammation. A small calcareous deposit was noted in the posterior inferior quadrant of the left membrane. An audiogram showed a conduction and perception loss of about 30 decibels in each ear.

Operation was done on July 28, 1941, with the area under local anesthesia. A modified submucous resection operation was performed, and the spur and ridge along the vomer on the left were removed, and the remaining bony portion of the septum was fractured toward the nasal midline (right). The right inferior turbinate body was fractured outward. A Simpson splint was inserted in the left meatus.

Follow-up investigation revealed that there had been a gradual improvement in the patient's subjective symptoms, with less tinnitus and less feeling of pressure in the ears. An audiogram taken Oct. 8, 1941, showed an average improvement in hearing of about 10 decibels. The improvement continued until the audiogram showed an average loss of less than 10 decibels. The gain in hearing was maintained, the last audiometric examination, on Jan. 3, 1945, showing substantially the same hearing as the audiogram on Jan. 25, 1943. On April 6, 1947, the appearance of the tissues of the nose showed some generalized congestion with moderate excess mucoid secretion.

CASE 9—Deafness, chronic purulent otitis media type, chronic bilateral purulent otitis media, chronic rhinosinusitis, deviated septum with nasal obstruction

A S., a man aged 28, was first seen on July 30, 1943. He complained of impaired hearing in both ears, severer on the right, slight tinnitus in both ears and an intermittent discharge from both ears. He reported frequent colds, difficulty in breathing through the nose and excessive postnasal discharge. Further complaints were of a feeling of dulness and heaviness in the "sinuses" and general fatigue. The otic condition had existed since childhood, when there was a discharge from both ears with pronounced loss of hearing. A double mastoidectomy had been performed at the age of 2 years. Recurring mastoiditis in 1922 had been treated with a double mastoidectomy. From age 16 to 25 his hearing had improved, but during last three or four years it had become worse. Examination of the ears showed well healed postauricular mastoidectomy scars on each side. There were large perforations in both tympanic membranes. There was a very slight purulent discharge from the left ear but no discharge from the right ear. An audiogram showed about a 35 decibel loss of hearing in right ear and a 25 to 30 decibel loss in the left ear. The nasal septum was deviated sharply to the left, with compensatory hypertrophy of the right middle and inferior turbinate bodies. Transillumination of the frontal and maxillary sinuses showed them to be fairly clear and equally illuminated. The tonsils had been removed. There was a moderate amount of granulation tissue in each tonsillar fossa.

Operation was done on Aug 9, 1943, with the area under local anesthesia. A modified submucous resection was performed, with realinement of the septum to the nasal midline and fracture of the right inferior turbinate body outward.

An audiogram made on Aug 9, 1945 showed an average gain in hearing of 23 decibels in the right ear and of 15 to 20 decibels in the left ear. The patient was free from colds and other nasal symptoms. On May 17, 1946 the right ear was still discharging, but the gain in hearing was maintained. The tissues of the nose appeared normal.

CONCLUSIONS

The forces of compensatory hypertrophy and simple atrophy are used by nature in an attempt to maintain the normal structure of the nose. Through intranasal surgical procedures, physiologic control of the nose can be accomplished by directing these forces.

When the bilateral symmetry of the nose is disturbed, natural adaptations occur which may not be advantageous to the patient, but when the aerodynamic balance is restored through intranasal operations, the normal physiologic processes can be reestablished, partially controlled and directed over a period of time sufficient for effective clinical recovery.

I have developed a simple corrective surgical technic to be applied in the different types of cases with nasal symptoms of varying degree, with or without compensatory changes in the turbinate bodies and contiguous structures, using a biomechanical approach. The compensatory area of the nose is redesigned in order to provide for "maintenance of organic structure" by forming a modified anatomic basis for the compensatory forces, which will then restore the normal physiologic processes. This technic should be applied with great caution in these critical anatomic areas and used only after careful study and complete understanding of the biomechanical principles involved.

The cases reviewed were selected from those of a diversified group of patients of different ages presenting the usual "sinus" symptoms. They include cases of headache, referred pain, allergy (hay fever and asthma) and three types of impaired hearing. All patients showed continued relief from symptoms after varying lengths of time following a corrective operation, including minor follow-up adjustment in some cases. The physiologic functioning of the nose having been directed within natural limits, no further treatment should be necessary.

Drs Peyton Rous, The Rockefeller Institute for Medical Research, New York, Francis M Rackemann, Boston, Victor Carl McCuaig, Duncan McCuaig, and Iago Galdston, New York, rendered assistance in this study.

STUDY ON THE RANGE OF USEFULNESS OF A NEW DUAL FORM INTRANASAL MEDICAMENT

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EXCLUSIVE of systemic drugs, there are literally hundreds of nasal medicaments available for the treatment of infections of the upper respiratory tract. These fall into a number of different classifications, such as (*a*) vasoconstrictors, (*b*) vasodilators, (*c*) silver preparations, (*d*) oils, (*e*) antiseptics, (*f*) topical anesthetics, (*g*) volatile agents, inhalers, (*h*) powders, (*i*) estrogens, (*j*) intranasal vaccines, (*k*) cauterizing agents, (*l*) saline solutions, (*m*) bacterial lysates, (*n*) emulsions, (*o*) inhalants, (*p*) nasal jellies, (*q*) nasal sprays and others. In addition, of course, there are the various antibiotics and newer detergent agents. Of vasoconstrictors alone—drops, sprays, inhalants, and jellies—Kully¹ estimated that there are several hundred on the market. As Fabricant² has aptly pointed out, of drugs in the classes listed, “many are useful and worthy of clinical trials, some are of questionable value, while others are detrimental to the nose and sinuses.”

In the relief and treatment of rhinitis due to the common cold, allergic rhinitis and sinusitis, the physician is confronted with the problem of choosing the most efficacious nasal medicament—and at the same time one that is free from side effects—from among a large variety of widely advertised drugs. What criteria should he use in his selection?

Freedom from interference with ciliary activity is generally held to be a prime requisite of medicaments intended for intranasal application. Second, the preparation should be slightly acid to approximate the p_H of normal mucous membrane. Third, it should be isotonic. And, lastly, it should be free from irritant qualities and from systemic by-effects. Recently, despite the apparent popularity of sulfonamide preparations for local application, the Council on Pharmacy and Chemistry of the American Medical Association³ has deleted this type of agent from “New and Nonofficial Remedies” because of sensitization occurring in a high proportion of patients treated.

From the Vanderbilt Clinic, Columbia University—Presbyterian Hospital Medical Center, service of Dr. John D. Kernan.

¹ Kully, B. M. Use and Abuse of Nasal Vasoconstrictor Medications, *J. A. M. A.* **127** 307 (Feb. 10) 1945.

² Fabricant, N. D. Nasal Medication. A Practical Guide, Baltimore, Williams & Wilkins Company, 1942, chap. 8, p. 81.

³ Sulfonamides for Local Application Deleted from N. N. R., report of the Council on Pharmacy and Chemistry, *J. A. M. A.* **135** 157 (Sept. 20) 1947.

It is worth while to emphasize the importance of the proper selection of a vasoconstrictor when one is used, for Lake ⁴ has recently reported on a condition called "rhinitis medicamentosa," arising from the abuse of nasal vasoconstrictors. He observed that "if the patient has over-treated the nose for only a short time, the turbinates appear only moderately congested. If the patient has overtreated his nose for a long time, the turbinates are congested and the mucous membrane of the nose appears pale, is boggy in texture and has the appearance characteristic of allergic rhinitis." The prevalence of this condition is emphasized by his statement that at the Mayo Clinic, "scarcely a day goes by but that some of us in the Section of Otolaryngology and Rhinology will see one or two patients who are the victims of abuse of nose drops." Many other clinicians ⁵ have also reported on the increasing incidence of this condition, in which the deeper blood vessels (rather than the subepithelial vasculature) are usually more involved.

That the manufacturers of some of the stronger vasoconstrictors appreciate the dangers attendant on overuse of their preparations on the part of the laity is evidenced by the fact that only recently one of the largest producers withdrew the most potent dosage form from retail drugstore channels and is retaining it for administration by the medical profession exclusively.

According to Lake, treatment of rhinitis medicamentosa consists in discontinuance of local therapy, sedation if necessary and measures designed to "alleviate the original trouble which led to the use of the nasal vasoconstrictors."

CLINICAL EXPERIENCE

In the search for the most efficacious and safe nasal medicament, I have tested a new local preparation ⁶ in 54 unselected cases of acute and

4 Lake, C F Proc Staff Meet, Mayo Clin **21** 367, 1946

5 (a) Clay, J V F Hahneman Monthly **81** 60, 1946 (b) Gill, J P Eye, Ear, Nose & Throat Monthly **25** 396, 1946 (c) Lake ⁴ (d) Ryan, R E Ann Otol, Rhin & Laryng **56** 46, 1947

6 The preparation used was narakon,[®] a product of Baybank Pharmaceuticals, Inc, a division of Chesebrough Mfg Co Cons'd. The compositions of the two dosage forms are stated by the manufacturer to be as follows

Solution Plain		Solution with Desoxyephedrine	
	Percentage		Percentage
Allantoin	0.40	Allantoin	0.40
Synthetic camphor	0.05	Synthetic camphor	0.05
Synthetic menthol	0.04	Synthetic menthol	0.04
Natural oil of cassia	0.02	Natural oil of cassia	0.02
Sodium monophosphate	1.80	Sodium monophosphate	1.10
Sodium biphosphate	0.74	Sodium biphosphate	0.50
Benzalkonium chloride 1:3,500	0.23	Benzalkonium chloride 1:3,500	0.22
Distilled water	96.72	Distilled water	96.67
Total	100.0	Total	100.00

chronic conditions of the upper respiratory tract. Patients were taken from my private practice and from the hospital clinic. The test solution was supplied in two forms: plain and with vasoconstrictor. It is a slightly acid, isotonic, aromatized, buffered solution, containing benzalkonium chloride (1:3,500) and allantoin, for use when an antiseptic, detergent, palliative solution (without immediate vasoconstrictive but with gradual decongestive action) is indicated. It is also supplied with added racemic desoxyephedrine (1 per cent) when potent but rebound-free shrinkage is desired.

Controlled bacteriologic tests⁷ have demonstrated that both forms of this solution exert marked antiseptic and bactericidal properties against four common organisms, even when diluted. (It is not suggested hereby that the preparation be diluted before administration; these laboratory tests were used merely to check bactericidal efficiency.) With use of isotonic sodium chloride solution for dilutions and testing against the organisms commonly found in the upper airways at 37 C, results were as follows:

Organism	Highest Dilution Killing in 15 Seconds	
	Solution Plain	Solution with Desoxyephedrine
<i>Staphylococcus aureus</i>	1:1	1:1
<i>Corynebacterium diphtheriae</i>	Undiluted	Undiluted
<i>Diplococcus pneumoniae</i>	1:2	1:2
Hemolytic streptococcus	1:2	1:2

Of the 54 patients in the series treated, 28 had sinusitis of various types, 7, rhinitis due to coryza, 5, nasopharyngitis, 2, acute infection of the upper respiratory tract, 5, allergic rhinitis, 3, allergic sinusitis, 1, crusting, dryness and perforated nasal septum, 1, chronic ethmoiditis with polyps, and 2, rhinitis medicamentosa (1 accompanying chronic ethmoiditis and nasal polyps). Twenty-eight patients were given the test solution exclusively, 26 received other medication also.

Of the 28 patients relieved completely by the test solution only, 15 had received diagnoses of sinusitis (6 acute, 9 chronic), 5, rhinitis (2 acute, 2 chronic and 1 with eustachian tube catarrh), 3, nasopharyngitis (2 acute and 1 subacute), 1, acute infection of the upper respiratory tract, 1, allergic rhinitis, 1, allergic sinusitis, 1, dryness, crusting and perforated nasal septum, and 1, rhinitis medicamentosa.

Thirteen of the patients with sinusitis (10 with acute and 3 with chronic) received inhalations of penicillin aerosol in addition to the test solution, 1 with atrophic rhinitis received inhalations of penicillin and vitamin A in addition to the test solution, 1 with acute rhinitis received inhalations of penicillin also—as did 2 with nasopharyngitis, 1 with

⁷ These tests were made by A. F. Guiteras in the bacteriologic laboratories of Foster D. Snell, Inc., New York.

Clinical Results in 54 Unselected Cases of Acute and Chronic Conditions of the Upper Respiratory Tract Treated with New Test Solution (in Dual Form)

Case No	Age	Symptoms	Examination	Diagnosis	Dosage,* Drops	Duration of Treatment, Days	Results and Comment
1	31	Nasal congestion, inflamed mucous membrane of nose and throat	Transillumination, antrums and frontal sinuses dark	Acute rhinitis	5 x 3	10	Immediate relief of nasal congestion after 3 days, symptoms free in 10 days
2	23	Stuffy nose, sore throat, swelling of nasal mucosa, postnasal drip		Acute nasopharyngitis	3 x 3	10	Good, nasal decongestion persisted for 2 to 6 hr, slight "burning" sensation when solution first instilled but marked improvement soon apparent, symptom free after 10 days
3	39	Blocked nose, impaired hearing with noise in right ear		Acute nasopharyngitis and catarrh of right middle ear	5 x 3	22	Nasal decongestion effected, continuous noise in right ear unaffected
4	21	Nasal obstruction, mucous discharge, postnasal drip	Transillumination, frontal and maxillary sinuses clear	Subacute nasopharyngitis	3 x 3	4	Good, nasal condition cleared rapidly after 2 days' treatment
5	16	Headaches above left eye for 2 wk, purulent nasal discharge	Roentgen, all sinuses clear except left frontal	Acute left frontal sinusitis	5 x 3	8	Subsidence of headache and nasal discharge
6	29	Profuse purulent nasal discharge for a few days, acute swelling of mucous membrane, headache above left eye, deflected nasal septum	Roentgen some thickening of left antral mucous membrane	Acute left pansinusitis	5 x 3	14	Disappearance of headache and nasal discharge
7	31	Frontal headaches every 3-4 mo for last 10 yr, postnasal drip, polyp in left middle meatus	Roentgen, frontal and left ethmoid sinusitis	Chronic sinusitis, pharyngolaryngitis	3 x 3	14	Headaches and nasal discharge disappeared, drops "burned" slightly on instillation, applied with patient prone, letting drops run against orifice of frontal sinus, polyps removed
8	40	Pains over and between eyes, mucous membrane of left inferior turbinate enlarged	Roentgen minimal thickening of lining of left maxillary sinus	Chronic rhinitis	5 x 3	21	Headaches relieved, nasal passages temporarily opened
9	55	Congested nasal passages, frequent sore throats, postnasal drip, severe cough	Roentgen, moderate clouding of both frontal sinuses, opacity of both antrums, moderate density of right anterior ethmoid cells	Bilateral chronic frontal and maxillary sinusitis, right ethmoid sinusitis, deflected nasal septum	3 x 3	7	Coughing stopped after 7 days congestion relieved
10	41	Difficulty in breathing, purulent discharge from nose for 4 days	Transillumination, frontals clear, antrums dark	Bilateral maxillary sinusitis, acute	4 x 3	5	Drops caused slight "burning" but kept passages clear so that patient could sleep, no difference in congestion observed when another powerful vasoconstrictor was used, 4 penicillin aerosol inhalations of 25,000 units each
11	52	Headaches, nasal stuffiness and discharge	Transillumination, frontals clear, maxillary sinuses dark	Chronic ethmoiditis, nasopharyngitis, incomplete right ethmoidectomy	5 x 3	25†	Good, discharge disappeared, head aches disappeared, 1 penicillin aerosol inhalation of 20,000 units
12	22	"Stuffy" nose	Transillumination, frontals clear, antrums hazy	Acute maxillary sinusitis	4 x 3	5	Good, patient pleased with effect of drops, some discharge still present 1 penicillin aerosol inhalation of 20,000 units
13	39	"Stuffy" nose		Acute upper respiratory infection	5 x 3	3	Good, improvement in nasal symptoms, 1 penicillin aerosol inhalation of 20,000 units
14	50	Blocked nose, small nasal polyps		Chronic ethmoiditis with small polyps	4	5	Good, marked relief of nasal symptoms, 2 penicillin aerosol inhalations of 20,000 units each

Clinical Results in 54 Unselected Cases of Acute and Chronic Conditions of the Upper Respiratory Tract Treated with New Test Solution (in Dual Form)—Continued

Case No	Age	Symptoms	Examination	Diagnosis	Dosage,* Drops	Duration of Treatment, Days	Results and Comment
15	23	Headache, postnasal drip, purulent discharge, deflected nasal septum	Transillumination, frontals clear, right antrum dark	Subacute bilateral sinusitis	3 x 3	25	No discharge visible after 27 days, 7 penicillin aerosol inhalations of 20,000 units each
16	42	"Stiffness" in nose, post nasal drip, purulent discharge	Transillumination, frontals clear, right maxillary sinus dark	Chronic maxillary sinusitis with acute exacerbation	5 x 3	14	Improvement in nasal breathing and lessening of acute symptoms after 6 days, decongestion of nose and symptomatic improvements, 5 penicillin aerosol inhalations
17	36	Purulent nasal discharge, difficult breathing	Transillumination, frontals and antrums clear	Acute rhinitis, deflected septum	5 x 3	10	Nose completely dry, 2 penicillin aerosol inhalations of 20,000 units each
18	57	Purulent discharge mainly from left nostril, headache	Transillumination, frontals clear, right antrum clear, left antrum dark	Left subacute maxillary sinusitis, myalgia	4.5 x 3	5	Lessening of discharge, headaches subsided, feels considerably better, 2 penicillin aerosol inhalations of 20,000 units each
19	25	"Stiffness" of nose 8 wk duration, congested mucous membrane	Transillumination, maxillary sinuses hazy	Chronic nasopharyngitis	5 x 3	2	Excellent, complete relief from all symptoms in 2 days, 1 penicillin aerosol inhalation of 20,000 units
20	14	Purulent discharge from both nostrils after head cold 4 wk previously	Transillumination, antrums dark	Subacute bilateral purulent maxillary sinusitis	5 x 3	12	Lessening of discharge, 7 penicillin aerosol inhalations and 2 Proetz treatments
21	39	Obstruction of nasal passage, pus in both nostrils for 4 days	Transillumination, antrums and frontals clear	Acute nasal cold	5 x 3	5	Acute condition improved, 2 penicillin aerosol inhalations of 20,000 units each
22	26	Pains in forehead	Transillumination, left frontal sinus dark	Acute left frontal sinusitis	5 x 3 into left nostril	7	Pain and discharge disappeared, 2 penicillin aerosol inhalations of 20,000 units each
23	21	Pain below left eye for 1 wk	Transillumination, left maxillary sinus dark	Acute left maxillary and ethmoid sinusitis	4 x 3	3	Cleared up, 1 penicillin aerosol inhalation of 20,000 units
24	31	Headaches for 12 yr, nasal discharge	Transillumination maxillary sinuses dark	Bilateral chronic sinusitis, deflection of septum to right	4.5 x 3	6	Lessening of discharge and headaches after 6 days, 2 penicillin aerosol inhalations of 20,000 units each
25	18	Occasional headache purulent nasal discharge for 2 wk	Transillumination, left frontal and both antrums dark	Acute bilateral maxillary and left frontal sinusitis	5 x 3	4	Cleared up completely, 3 penicillin aerosol inhalations of 20,000 units each and 1 insufflation of sulfadiazine powder
26	39	Offensive smelling mucus, mucous membrane of both inferior turbinates engorged, allergic	Transillumination, frontals and maxillary sinuses clear	Allergic rhinitis	5 x 3	19	Relief of headaches and nasal congestion
27	30	Attacks of sneezing, watery nasal discharge	Röntgen, frontals show no evidence of disease—clouding of lower right ethmoid cells, thickened lining membranes in both antrums	Bilateral antrum and right ethmoid sinusitis (allergic basis)	3 x 1	7	Nose open, feels well, no complaints
28	42	Clogged nose, pus in both nostrils, pain below right eye		Allergic rhinitis, acute pansinusitis	5 x 3	1	Cleared up in 6 days, prefers test solution to others, 4 penicillin aerosol inhalations of 20,000 units each

29	26	Frequent headaches, postnasal drip, crusting of mucous membranes	Transillumination, antrums and frontals clear	Allergic rhinitis	3 x 3	6	Improvement of postnasal drip, drops were used after penicillin aerosol in halation treatments, and after test solution was discontinued, anti his tamine tablets were administered Good, topical application maintained patent nasal airway
30	30	Chronic nasal stuffiness	Transillumination, frontals clear, antrums hazy	Chronic sinusitis myo carditis	Tampons soaked with plain solution for 5 min x 3	11†	Very good after 1 week improvement in breathing and decrease in puru lent discharge, after 21 days pus dried up and covered mucous mem brane in form of crusts, chronic con dition greatly improved, no more headaches, after using drops for 74 days felt considerably improved, no side reactions
31	61	Stuffed nose, mucous mem brane covered with pus	Röntgen, heart of hyper tensive configuration sinu stus involving antrums and ethmoid sinuses, sphenoid cells clear, left ventricle enlarged, arteriosclerotic changes in region of aortic knob	Chronic maxillary and ethmoid sinusitis, hyper tension	10 cc (plain) on tampons x 1 or 2	74	After trying almost every kind of available nose drops, patient states that test solution relieved clogging of nose and permitted undisturbed sleep at night
32	36	Obstruction of nasal air way, purulent discharge	Transillumination, frontals clear, antrums dark	Chronic bilateral maxillary sinusitis, hyper tension	3 (plain) x 3	42	Mucous discharge of nose subsided
33	57	Mucous discharge	Transillumination, sinuses clear	Catarrh of left eustachian tube, acute nasal cold	Nasal spray (plain) x 3	5	Dryness and crusting improved
34	71	Dryness and crusting of nose	Transillumination frontals clear, both maxillary sinuses hazy	Perforation of nasal septum	Well soaked cotton pledgets in both nostrils (plain) 10 to 15 min x 2	3	Patient used vasoconstrictors with little effect for 6 months continuously day and night great improvement in relation short time with test solution plain and tamponage
35	75	Complete obstruction of nasal passages through engorgement of mucous membrane, deflected septum	Transillumination right frontal clear, left frontal cloudy, antrums dark	Rhinitis medicamentosa	Tampons (plain) for 5 min x 2	10	One penicillin aerosol inhalation of 20,000 units, had attack of coronary thrombosis 6 mo previously, left antrum operated on at age 17, im provement in nasal breathing
36	49	Obstruction of nasal passage	Transillumination, frontals clear, antrums dark	Acute sinusitis	Tampons (plain) for 10 min x 2	5	Nasal passages open, discharge sub sided
37	63	Nasal obstruction and dis charge, coughing spells for 2 wk	Transillumination, frontals clear, antrums dark	Deflection of nasal sep tum, atrophic rhinitis	Nasal spray (plain)	4	Lessening of crusting, discharge still present, test solution used for over 3 wk, 5 penicillin aerosol inhalations and vitamin A
38	20	Purulent discharge, crust ing	Transillumination, frontals clear, maxillary sinuses clear	Allergic rhinitis, hyper trophy of posterior ends of both inferior tur binates	Cotton pledgets (plain) 3 to 5 min (warmed) x 2	21+	Helped to keep airway open, al legedly, patient could breathe even while tamponades were in her nos trils, antihistamine tablets and e'ec trocauterization of interior tur binates
39	27	Two day headache wat ery nasal discharge, bouts of sneezing	Transillumination, right maxillary hazy, frontals clear	Chronic sinusitis	5 x 3, changed to plain solution after 6 days	7	Airways open, pus still present in nose, therefore changed to solution plain, 3 penicillin aerosol inhalations of 20,000 units each
40	32	Nose clogged mucous dis charge, occasionally bad smelling, for about 10 yr ; dull headache, frequent colds	Transillumination, frontals clear, maxillary sinuses dark	Chronic frontal and maxillary sinusitis	2 or 3 x 3	6	Nasal cavity remained open, drops well tolerated, during this time pa tient did not use any other intra nasal medication
41	47	Nasal obstruction, nasal discharge	Transillumination, antrums and frontal sinuses cloudy	Chronic frontal and maxillary sinusitis		150*	

Clinical Results in 54 Unselected Cases of Acute and Chronic Conditions of the Upper Respiratory Tract Treated with New Test Solution (in Dual Form)—Continued

Case No	Age	Symptoms	Examination	Diagnosis	Dosage * Drops	Duration of Treatment, Days	Results and Comment
42	23	Clogged nose for several mo., nasal discharge	Transillumination, frontals clear, maxillary sinuses hazy	Chronic maxillary sinusitis	5 (plain) × 2	27	Nasal discharge stopped, but a slight postnasal drip remained, patient smokes 1 pack of cigars a day
43	57	Obstructed nasal breathing	Transillumination, frontals clear, maxillary sinuses hazy	Allergic rhinitis	3 to 5 × 1	7	Relief obtained in combination with other treatment, received dust injections and cauterization of turbinates
44	42	Pain above left eye	Transillumination, left frontal and left maxillary sinuses dark	Chronic left frontal and maxillary sinusitis	5 × 3	7	Still some discharge of pus from sinuses
45	45	Discharge from right nostril	Transillumination, frontals clear, right maxillary sinuses dark	Acute maxillary sinusitis, exudate in right middle ear	3 × 3 In right nostril	1	Relief reported the next day
46	57	Attacks of pain above left eye	Transillumination, left frontal and maxillary sinus dark	Acute left frontal and maxillary sinusitis	7 (plain) × 3	7	Blood pressure 190/100, received "emphrin", vasoconstrictor contraindicated, but solution plain well tolerated with no side effects
47	39	Nasal discharge nasal obstruction	Transillumination, maxillary sinuses cloudy	Allergic sinusitis	3 × 2	15	Dust injections and "benadryl" plus test solution relieved allergic complaints
48	21	Obstruction of nasal breathing	Transillumination, maxillary sinuses hazy	Epilepsy, allergic sinusitis, deflection of nasal septum to left	5 × 1	15	Dust injections plus test solution reduced congestion temporarily
49	55	Nasal discharge	Transillumination, frontals clear, maxillary sinuses dark	Chronic maxillary sinusitis	3 × 3	7	Patient has auricular fibrillation, arteriosclerosis and myocardial damage, vitamins administered, nose appeared dry
50	55	Obstructed nasal breathing		Nasal polyps, chronic ethmoiditis, overuse of vasoconstrictors	3 × 3	7	Dust injections and "calcibronat" tablets administered, test solution well tolerated despite rhinitis medication
51	21	Deafness and noise right ear	Transillumination, sinuses clear	Exudate right middle ear, acute head cold	5 × 3, In right nostril	5	Feels well, symptoms disappeared
52	81	Occasional discharge from nose, formation of crusts		Chronic rhinitis	5 (plain) × 1 in each nostril	10	Crusts and discharge subsided, complaints of slight dizziness and headache 5 min after instillation of drops, albumin and trace of sugar in the urine and few red cells, blood pressure 175/90
53	62	Deafness and pain in left ear		Acute nasal cold, acute otitis left ear	3 × 3 in each nostril	6	Eardrum looks almost normal, symptoms disappeared
54	47	Nasal discharge, pain radiating into right eye and right molar teeth		Acute right maxillary sinusitis	5 × 2	7	Relief of pain, lessening of discharge

* Unless otherwise specified the solution with desoxyephedrine was used

† Treatment was intermittent

‡ Five treatments

chronic ethmoiditis, 1 with acute infection of the upper respiratory tract and 2 with allergic rhinitis. Antihistamine tablets were administered to 1 patient with allergic rhinitis, and the inferior turbinate bodies were cauterized, another patient with allergic rhinitis received dust injections and was cauterized also, 2 with allergic sinusitis were given dust injections, 1 receiving diphenhydramine hydrochloride (benadryl hydrochloride®) as well, and finally, 1 with rhinitis medicamentosa received dust injections and calcium bromidogalactogluconate (calci-bronat® tablets). Full details as to diagnosis, symptomatology, treatment and results are supplied in the table. It will be noted that 39 patients received the test solution with vasoconstrictor, 15, the test solution plain, and 1, the test solution with vasoconstrictor followed by test solution plain. The test solution plain was administered to 6 patients with hypertension, 2 with cardiac involvements and 2 with rhinitis medicamentosa.

RESULTS OF TREATMENT

In my experience, the use of both forms of this solution gave prompt and good results, with complete freedom from side effects in all but 3 cases. Two patients complained of a slight "burning" sensation with use of test solution with vasoconstrictor, but continued its use with benefit, 1 patient, aged 81, with hypertension reported a sensation of slight dizziness and headache five minutes after instillation of drops of test solution plain. It is noteworthy that the 5 hypertensive patients and the 2 with cardiac disease, using the test solution plain, experienced no systemic by-effects.

With both forms of test solution, effective but safe decongestion was achieved, relief from pain and headache was considerable, mucous discharge was lessened, postnasal drip decreased, and dryness and incrustations were markedly ameliorated.

Two cases are of particular interest.

One patient, 61 years of age, used the solution plain continuously (5 drops three times daily) for seventy-four days, with one week's interruption. She suffered from chronic maxillary and ethmoid sinusitis and arteriosclerotic hypertension. Continuous improvement of breathing and reduction in discharge, postnasal drip and headaches were observed. No undesirable local or systemic by-effects were experienced.

Another patient 55 years of age, had had allergic rhinitis for many years, and when she came for treatment her nasal passages were completely obstructed from abuse of vasoconstrictors, which she had used for six months continually, morning and night. Tampons well soaked with the plain solution applied for ten days kept the airways completely open and satisfactorily cleared the superimposed rhinitis medicamentosa.

The second is particularly interesting in view of the general consensus that the most effective treatment for the relief of this condition, as Ryan ^{5d} stated, is discontinuance of the use of nose drops

As to form of administration, there appears to be no particular technique which produces superior results. Drops, spray and saturated tampons were used with equal success. In tamponage, the patient was advised to pack only loosely to avert any possibility of ciliary damage. In use of drops, a most important factor is the position of the head, it should be tilted slightly backward and laterally, toward the nostril into which drops are being instilled.

In the 13 patients with sinusitis who received penicillin additionally, the test solution proved helpful in opening the nasal passages for more effective distribution of the penicillin and in preventing the congestion of the mucous membranes often caused by this antibiotic agent.

SUMMARY

A new slightly acid, isotonic, aromatized, buffered, aqueous solution containing benzalkonium chloride (1:3,500) and allantoin, both plain and with desoxyephedrine (1 per cent), was used in the treatment of 54 unselected patients with acute and chronic infections of the upper respiratory tract, including sinusitis, nasopharyngitis, rhinitis and others. Twenty-eight patients received the test solution exclusively, 26 also received other medication.

The solution with desoxyephedrine was administered to 39 patients, the solution plain was administered to 15 and both forms to 1. It was used in the form of drops, spray and saturated tampons.

Duration of treatment varied from one day (in a patient with acute maxillary sinusitis) to over seventy days (in a patient with chronic maxillary ethmoid sinusitis with arteriosclerotic hypertension).

Results were good in most cases, with pronounced relief of pain, headache and nasal "stuffiness", mucous discharge was lessened, post-nasal drip decreased, and dryness and incrustations improved greatly. In the 13 patients with sinusitis who received penicillin additionally, the test solution proved helpful in opening the nasal passages for more effective distribution of the penicillin and in preventing the congestion of the mucous membrane frequently caused by this antibiotic agent.

There was no evidence of irritation of the mucous membrane or any indication of allergic sensitization, except in 3 of the 54 patients. Two patients complained of a slight "burning" sensation with the use of the test solution with vasoconstrictor, but continued its use with benefit. There were also no systemic reactions, such as cardiac disturbances, nervousness or insomnia, nor other evidence of toxicity (except in 1 hypertensive patient aged 81, who complained of slight dizziness five minutes after instillation of the test solution plain). It is especially

noteworthy that the solution plain proved completely safe for the 5 patients with hypertension (1 patient used it for seventy-four days), 2 with cardiac disease and 2 with rhinitis medicamentosa

From my experience, it appears that the test solution in the plain form should prove particularly helpful in those cases in which ephedrine and ephedrine-like substances are contraindicated, as in diseases of the upper respiratory tract complicated by hypertension, arteriosclerosis, vasomotor rhinitis, pregnancy, old age, etc. It may also be safely and beneficially used over long periods in treatment of sinusitis and other chronic conditions for its antiseptic, detergent, apparently mildly astringent and emollient properties. The form containing desoxyephedrine is valuable in cases in which potent, rebound-free antiturgescient medication is indicated. After the vasoconstrictor form has provided ventilation and drainage in the acute phase, any needed subsequent treatment may be continued with the solution in plain form.

Administration of the test solution in either form does not, of course, preclude the need in some cases for systemic or other medication aimed at relieving or eliminating the underlying cause.

TYMPANOSYMPATHETIC ANESTHESIA FOR TINNITUS AURIUM AND SECONDARY OTALGIA

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TINNITUS aurium is frequently a symptom of disease of the inner ear and often a symptom of disease of the middle ear. In the absence of an active pathologic process in the ear, tinnitus is the result of a constitutional disorder. While the exact physiologic mechanism of this distressing symptom has not been explained satisfactorily, a number of theories have been proposed, none of which, however, has been proved therapeutically.

In the appraisal of all aural symptoms, tinnitus is the most distressing, and it often is of such annoyance as to cause the patient constant torture. This distressing situation produces an inability to concentrate and prevents the carrying out of routine daily duties. In addition, it often becomes worse during the night and prevents adequate sleep and rest. In many persons tinnitus finally produces mental depression and other mental disorders.

Tinnitus aurium per se is a symptom localized to the ear and should not be confused with head noises in general. True tinnitus aurium, or intrinsic tinnitus, is subjective and remains localized to the ear.

It differs from head noises, or extrinsic tinnitus, in that head noises move about in the head, so that the patient may complain of noises in the forehead, in the top of the head, in the ears and at the base of the skull.

A careful history as to the nature and characteristics of the noise is important in the differential diagnosis of tinnitus. Fowler¹ classified tinnitus as vibratory, caused by actual autogenous vibrations reaching the ear from any part of the body, and nonvibratory, caused by biochemical irritation of the auditory neural mechanism. It is the nonvibratory, or intrinsic, type with which this study is concerned. While nonvibratory, or intrinsic, tinnitus may gradually become louder after

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1 Fowler, E. P. Head Noises and Deafness. *Peripheral and Central, Laryngoscope* 49:1011 (Oct) 1939, *Tinnitus Aurium in the Light of Recent Research*, *Ann Otol, Rhin & Laryng* 50:139 (March) 1941.

weeks or months, wide daily variations are exceptional. This is not true of extrinsic tinnitus, or head noises, which varies greatly from day to day and often undergoes frequent variations in character and intensity on certain days. The subjective noises of intrinsic tinnitus take the form of high-pitched tones—chirping, singing sounds, the sound of escaping steam or boiling water, ringing, buzzing, pulsating sounds and the long shrill notes of the cicada.

Since intrinsic tinnitus is obviously a symptom of neural involvement occurring in disorders of the middle and the internal ear, it is logical to assume that the neural elements of these structures must play a part in the production of this annoying symptom. Fowler² also

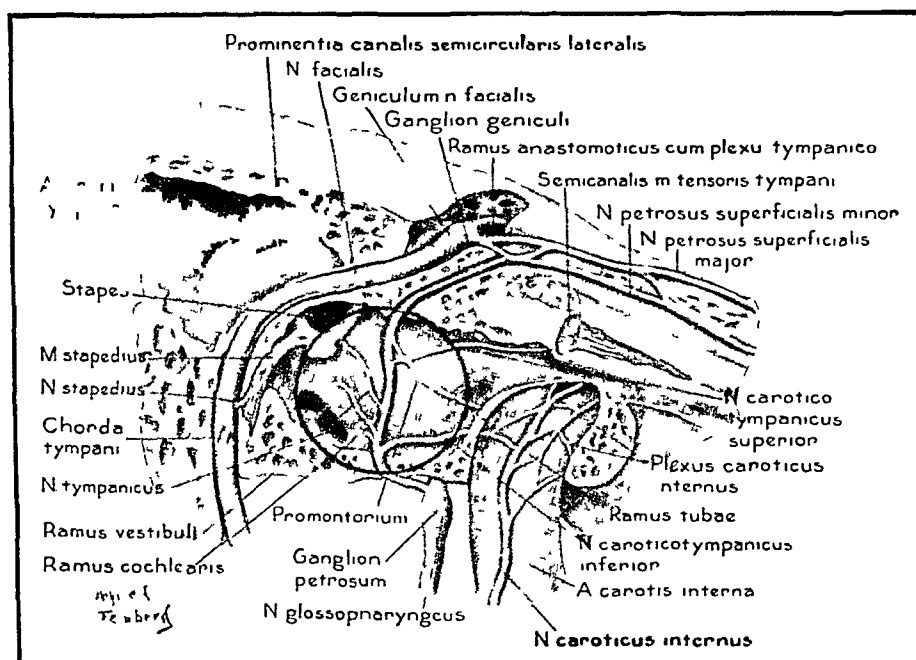


Fig 1—The tympanic plexus and its rami vestibuli and cochlearis (after Lempert³)

stated that nonvibratory (intrinsic) tinnitus is caused by irritation of the auditory nerve or, more properly, the auditory neural elements. Furthermore, it has been observed that there is an intimate nerve connection between the neural elements of the middle ear and those of the internal ear. The tympanic plexus, which constitutes the neural elements of the middle ear, is connected with the cochlear neuromechanism of the internal ear through the ramus vestibuli and the ramus cochlearis (fig 1).

² Fowler, E. P. Nonvibratory Tinnitus, *Arch Otolaryng* 47:29 (Jan) 1948

Lempert³ described the tympanic plexus as arising from the sensory fibers of the trigeminus, sympathetic and glossopharyngeal nerves (fig 2)

Jacobson's nerve, which arises from the glossopharyngeal nerve, is the most highly developed in the tympanic plexus. This nerve contains isolated ganglion cells. It passes from the fossa jugularis through an opening in the inferior tympanic wall and, extending upward in a groove in the promontory, anastomoses with the small superficial petrosal nerve, which arises from the trigeminus.

The sympathetic nerves of the lining membrane of the middle ear arise from the sympathetic plexus accompanying the carotid artery. Several small branches of this plexus enter the tympanic cavity through orifices in the carotid canal as the superior and inferior caroticotym-

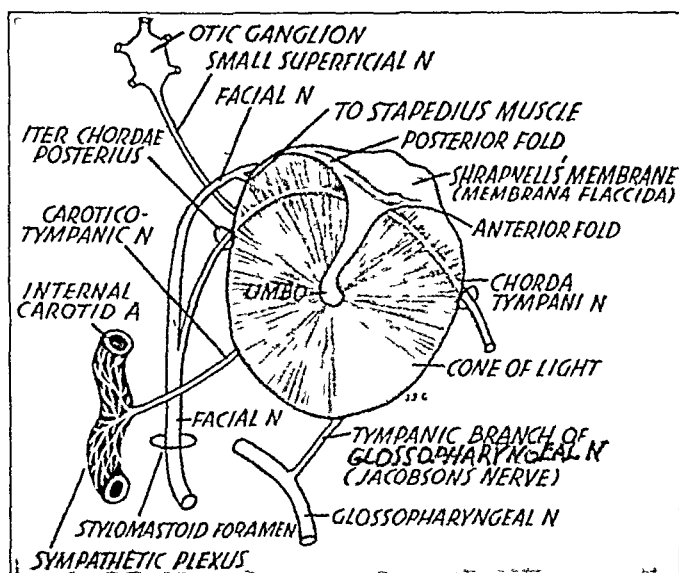


Fig 2—Origin of the tympanic plexus from the fifth nerve (small superficial petrosal), the ninth nerve (Jacobson's) and the carotid sympathetic nerves. After Barnhill.

panic nerves. These, in conjunction with the small branches of Jacobson's nerve and the small superficial petrosal nerve arising from the trigeminus, form the tympanic plexus in the anterior portion of the tympanic cavity. Arising from this plexus are smaller nerve branches, which supply the entire lining membrane of the middle ear and in which one finds, in the regions of the fenestra vestibuli and fenestra cochlearis, clusters of ganglion cells. In addition, a delicate, ramifying network of nerve fibers is found, which spreads partly above and partly below the vessels and forms ganglionic swellings where several fibers meet.

3 Lempert, J. Tympanosympathectomy. A Surgical Technic for the Relief of Tinnitus Aurium, *Arch Otolaryng* 43:199 (March) 1946.

A large branch arising from the tympanic plexus runs also to the cartilaginous eustachian tube

Through this connection of the trigeminus, sympathetic and glossopharyngeal nerves, which form the tympanic plexus, tinnitus aurium may be produced by pathologic changes in the middle ear and in neighboring structures, such as the teeth, pharynx, nose and eustachian tube. It seems to make little difference whether the active lesion is located in the middle ear or in the neighboring structure, since the impulse which produces tinnitus is transmitted or relayed from the middle ear to the inner ear by the tympanic plexus. Apparently, the tympanic plexus acts as a central nerve plexus, receiving impulses through its connections with the ninth nerve, the fifth nerve and the carotid sympathetic fibers. These impulses are manifested either by tinnitus or by aural pain. Presumably, the intimate connections of the tympanic plexus with the inner ear through the ramus vestibuli and the ramus cochlearis create two phases in aural response to stimulation. Impulses of a minimal nature traverse the tympanic plexus without initiating a reaction of pain but are adequate to stimulate a reaction of tinnitus in the sensitive cochlear neuromechanism. Finally, if the stimulation becomes more intense, a reaction of pain occurs through stimulation of the tympanic plexus itself. The initial phase of minimal irritation is a subthreshold phase, resulting in tinnitus, and the secondary phase is a suprathreshold phase, resulting in pain.

While histologic investigations so far have not definitely demonstrated and established the neural connections between the tympano-sympathetic fibers and the cochlear neuromechanism, there is much clinical and experimental evidence to support the belief that they exist. Observations made in the course of suppurative inflammations of the middle ear, and pharyngeal, lingual and dental infections suggest a definite physiologic relation between tinnitus aurium and secondary or referred otalgia. The following clinical observations tend to confirm the presence of these neural connections and their importance in producing tinnitus aurium and reflex otalgia from involvement of the middle ear and its neighboring structures.

The association of tinnitus with acute suppurative otitis media, particularly in its early stages, is commonly observed. Furthermore, it is observed that otalgia and tinnitus aurium frequently coexist in the presence of acute inflammatory lesions of the middle ear. When inflammation of the middle ear subsides, tinnitus and otalgia subside, this occurrence leads to the conclusion that the physiologic structures within the middle ear involved in otalgia and in tinnitus aurium are one and the same, or are intimately related in some manner. In cases of acute suppurative inflammation of the middle ear spontaneous or induced drainage immediately diminishes otalgia and tinnitus. The mechanism by which tinnitus and otalgia are produced can be compared with that of

any inflammatory process. For example, drainage of an abscess alleviates pain because pressure within the abscess cavity is reduced. Complete relief from pain is obtained when the inflammatory reaction within the surrounding tissues has disappeared.

The same process of inflammatory edema and pressure on neural fibers produces tinnitus and otalgia in the middle ear cavity. Since the tympanum is more or less in direct connection with the cochlea through the fenestra vestibuli, and especially through the fenestra cochlearis, the effect of fluid pressure from the middle ear on these fenestrae must be evaluated in the production of tinnitus. It is common belief that the accumulation of inflammatory exudates in the middle ear and the effect of their pressure on the fenestrae initiate tinnitus in the cochlear mechanism. In order to observe the effect of fluid pressure within the middle ear, experiments were performed with patients who were entirely free of tinnitus. Isotonic sodium chloride solution was injected into the middle ear through the intact tympanic membrane with a fine caliber hypodermic needle so that the tympanum was completely filled with fluid. The effect of pressure of the fluid was accentuated by having the subject incline the head to the side so that the fluid covered the fenestrae to the internal ear. In only 1 patient was tinnitus or otalgia induced by fluid pressure in the middle ear. It is evident, therefore, that tinnitus and otalgia are not caused by pressure effects alone but are the result of the inflammation of some anatomic structure within all or a part of the tympanum. Apparently, inflammatory involvement of the tympanic plexus is responsible for these symptoms. In suppurative otitis media inflammation of the mucosa of the promontory involves the tympanic plexus in an inflammatory process, which, in turn, produces tinnitus and otalgia. Purulent exudation in the middle ear further increases tinnitus and pain by the effect of pressure on the inflamed tympanic plexus. Draining of the middle ear by myringotomy or spontaneous rupture partially alleviates pain and tinnitus through removing pressure on the involved tympanic plexus. Further reduction in tinnitus or otalgia occurs as the inflammatory edema involving the tympanic plexus resolves with the disappearance of the infection. In view of these findings, and of Lempert's observations on the otoneurology of the tympanic plexus, in which he noted clusters of ganglion cells in the regions of the fenestra vestibuli and the fenestra cochlearis, there apparently is a definite relation between the histopathologic state of the tympanic plexus and the symptom complex of tinnitus. When ganglionitis occurs in the region either of the round or of the oval window, a tonus impulse is transmitted to the inner ear which is interpreted as tinnitus. These clinical observations when correlated with the onset and recession of tinnitus indicate that the tympanic plexus is the initial source of the stimulation leading to tinnitus from inflammation of the middle ear.

Clinical observations made on numerous other pathologic conditions further substantiate the belief that the tympanic plexus is a definite segment in the neural pathway which produces tinnitus. The anatomic connections and reflex pathways that are associated with referred otalgia are well known. While tinnitus is an equally common symptom in such conditions, little effort has been made to explain its neural pathways. In view of the identical pathologic conditions producing tinnitus and otalgia and the similarity of onset and recession of these symptoms, it is suggested that the same neural pathways may be responsible for them. The well known pathologic conditions that produce otalgia or tinnitus, or both, are acute suppurative sialadenitis, chronic sphenoiditis, chronic adhesive otitis media, acute occlusion of

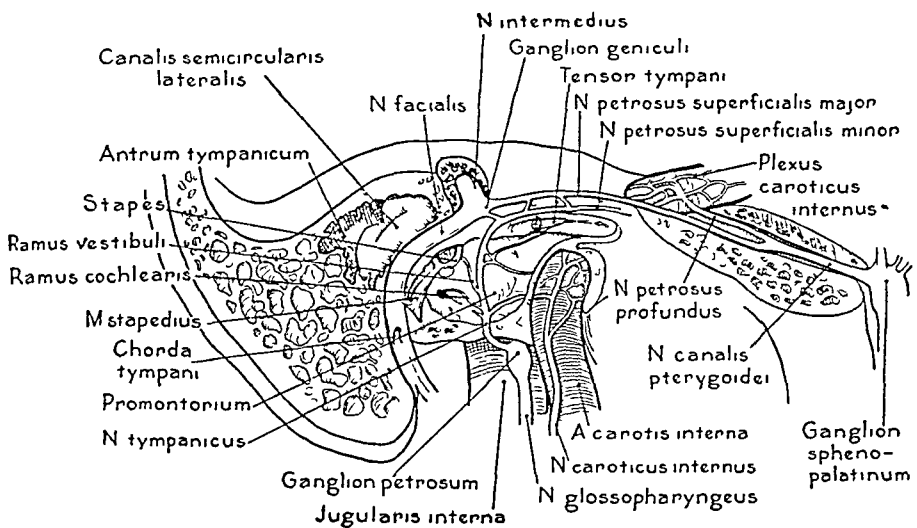


Fig 3—Neural pathway of tinnitus and otalgia from the nose and sinuses via the sphenopalatine ganglion. After Lempert

the eustachian tube, abscessed teeth, ulcerative lesions of the pharynx or of the larynx and inflammation of the nose and sinuses.

Figure 3 illustrates the neural pathway of secondary or referred otalgia and tinnitus arising from chronic sphenoiditis and other inflammations of the nose and sinuses. Impulses are transmitted from the sphenopalatine ganglion through the greater superficial petrosal nerve to the tympanic plexus to incite tinnitus via the connecting ramus vestibuli and ramus cochlearis or to produce aural pain in the tympanic plexus itself.

The course of reflex pain or tinnitus from an abscessed tooth is by way of the inferior dental nerve through the auriculotemporal nerve to the otic ganglion and then to the tympanic plexus through the lesser superficial petrosal nerve (fig 4).

Acute occlusion of the eustachian tube and ulcerative lesions of the pharynx and of the posterior third of the tongue giving rise to tinnitus or otalgia do so by reflex pathways through the glossopharyngeal nerve (fig 5)

One particularly common condition producing tinnitus or aural pain through the glossopharyngeal nerve is ulceration of the faucial pharynx following tonsillectomy

Circulatory disturbances of the internal carotid artery are responsible for tinnitus in a large number of persons The pulsating, or throb-

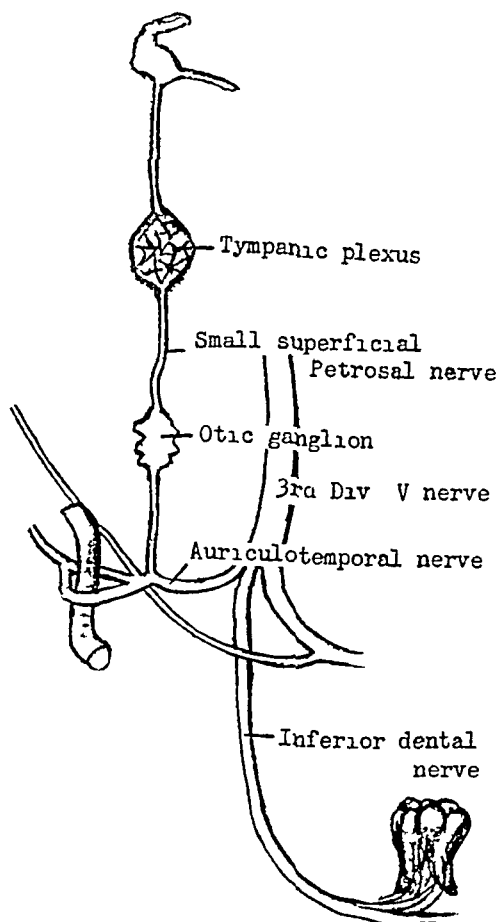


Fig 4—Neural pathway of tinnitus and otalgia from an abscessed tooth After Barnhill

bing, type of tinnitus is characteristic of these vascular disturbances The acoustic effect of vascular changes in the carotid artery can be easily demonstrated by digital pressure on the carotid plexus in the neck Tinnitus can be initiated or, if present, changed in character by digital pressure on the carotid plexus² The reflex pathway is through the plexus caroticus to the plexus caroticus internus, and then by way of the nervus caroticus tympanicus inferior and nervus caroticus tym-

panicus superior to the tympanic plexus, where the impulse is transmitted to the cochlea through the ramus vestibuli and the ramus cochlearis (figs 1 and 3)

Familiar examples of intracranial vascular disturbances which set up or accentuate tinnitus through the sympathetic caroticotympanic mechanism are straining at stool, interference with cranial circulation, such as occurs in the head-down position, constriction at the waist, such as occurs during bending action, and constriction at the throat, such

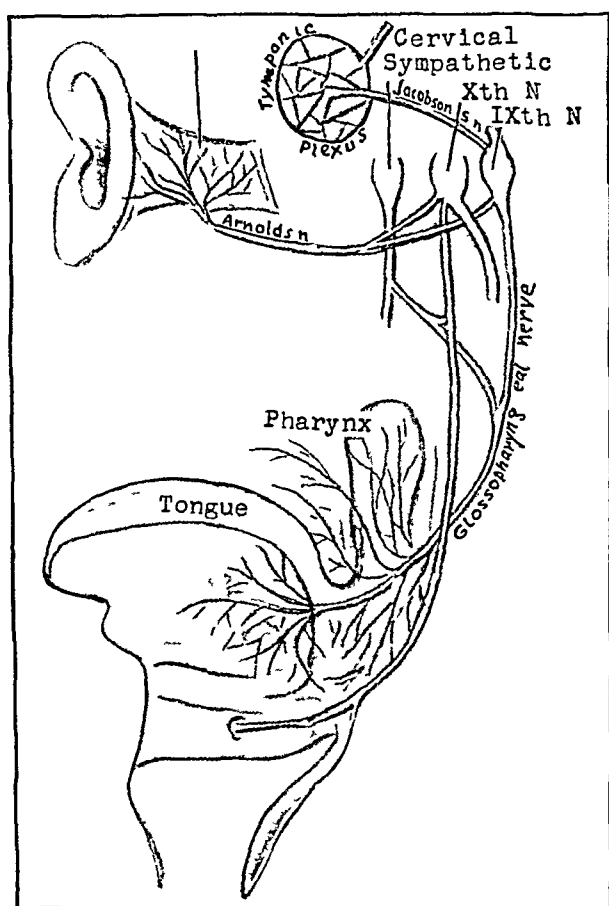


Fig 5—Neural pathway of tinnitus and otalgia from the tongue and the pharynx After Barnhill

as occurs with wearing tight neck bands One of the more constant causes or accompaniments of tinnitus is arteriosclerosis

According to Lempert, when ganglionitis involves the sympathetic caroticotympanic filaments coming from the carotid plexus, a tonus impulse is transmitted to the inner ear, where it is interpreted by the organ of Corti as pulsating tinnitus

Another likely source of vascular tinnitus is the middle meningeal artery In figure 4 it is observed that two roots of the auriculotemporal nerve form a complete loop around the middle meningeal artery This

peculiar neural arrangement occurs just below the foramen spinosum, through which the middle meningeal artery enters the middle fossa of the cranial cavity. The inaccessibility of this region to neurosurgical approach and to postmortem study has resulted in little information being gained concerning the relation of the middle meningeal artery to the symptom complex of tinnitus aurium. The anatomic arrangement of the auriculotemporal nerve in this location is similar to that of the left recurrent laryngeal nerve as it loops around the arch of the aorta. Laryngeal conditions resulting from vascular abnormalities of the aorta as they affect the left recurrent laryngeal nerve are well known. Presumably, in a similar manner, vascular abnormalities of the middle meningeal artery produce tinnitus through the auriculotemporal nerve. The neural impulses are transmitted by the auriculotemporal nerve to the otic ganglion and then to the tympanic plexus through the lesser superficial petrosal nerve.

Another particularly significant observation on the role of the tympanic plexus in relation to tinnitus is the "peach glow" discoloration (Schwartz sign) of the promontory seen in otosclerosis. Often the initial symptom of otosclerosis is an annoying and distracting tinnitus. In many instances, especially early in the disease, there is observed through the tympanic membrane a "peach glow" or "flamingo red" tinge, indicative of hyperemia in the cochlear promontory, or of thickening and increased vascularity of the mucosa of this region, in which the tympanic plexus is located. These observations strongly suggest a relation between the histopathology of the tympanic plexus and the symptom complex of tinnitus.

While the histologic and anatomic structure of the tympanic plexus, with its distribution of branches, filaments and ganglionic swellings, lends itself to a reasonable explanation of intrinsic tinnitus, it must be remembered that there exist sound observations on tinnitus with relation to the histopathology of the eighth nerve and lesions of higher nerve centers. These various observations on the explanation of tinnitus in no way discredit one another but give rise to an original concept that intrinsic tinnitus may originate either centrally or peripherally with the cochlea as the focal neuromechanism of response. Common sources of central intrinsic tinnitus are acoustic neurofibromas, lesions of the cerebellopontile angle and some drug allergies.

The histopathology of drug sensitivity is not clear in its relation to the production of tinnitus. Heretofore, the effect of quinine, salicylates and the arsenicals in the production of tinnitus was thought to be of central origin. However, observations on the effect of quinine⁴

4 Bishop, S. S. *Diseases of the Ear, Nose, and Throat and Their Accessory Cavities*, ed. 3, Philadelphia, F. A. Davis Co., 1905, p. 522.

showed that it produced congestion of the middle ear, as well as of the labyrinth. This observation indicated that tinnitus could arise through congestion of the middle ear, involving the tympanic plexus, hence, tinnitus of this nature would be of the peripheral intrinsic type.

On the basis of some of the aforementioned histologic, anatomic and clinical observations, experiments in injection of the tympanum to eliminate tympanosympathetic tinnitus have been carried on during the last seven years. A preliminary report⁵ on the use of ethylmorphine hydrochloride for this purpose was published some years ago. Since then, several revisions in technic have greatly improved the results of tympanic injection. While in pharmacologic classification, ethylmorphine hydrochloride U. S. P. is an analgesic, it also exhibits anesthetic characteristics when injected into the tympanum. This drug has proved to be effective in the treatment of tinnitus and secondary otalgia because of its combined anesthetic and analgesic qualities.

The therapeutic value of ethylmorphine hydrochloride in removing pupillary exudates and in absorbing interstitial corneal deposits by producing pronounced inflammatory edema has long been known in ophthalmology. It acts as a vasodilator and lymphagogue, stimulating the vascular and lymphatic circulation of the eye and producing pronounced dilatation of the blood vessels and lymphatics. It is for these physiologic effects on the tissues of the promontory and the tympanic plexus that this drug is used in injections into the tympanum. Ethylmorphine hydrochloride is particularly effective for this purpose because it has a selective action on neural tissue. Immediately after injection of the drug into the tympanum, the inflammatory reaction the solution produces can readily be observed through the otoscope. The entire drum membrane, particularly Shrapnell's membrane, becomes congested. Although definite inflammatory discoloration of the drum membrane occurs, the landmarks are not obscured by edema. The fluid line of the ethylmorphine hydrochloride solution can easily be seen through the tympanic membrane. The patient experiences little discomfort, since the drug produces analgesia, which counteracts the discomfort of the injection and the subsequent inflammation. This factor is of practical importance, as the patient is not incapacitated and is able to continue at his daily occupation, without discomfort. The therapeutic effect of the drug injected into the tympanum results from its analgesic action on the tympanic plexus and from its rehabilitating action on the tissue of the middle ear, by stimulation of vascular circulation and the subsequent absorption of interstitial fibrosis.

5 Trowbridge, B. C. Injection of the Tympanum for Chronic Conductive Deafness and Associated Tinnitus Aurium. A Preliminary Report on the Use of Ethylmorphine Hydrochloride; *Arch. Otolaryng.* **39** 523 (June) 1944.

SELECTION OF CASES

If good results are to be obtained, the cases for injection must be properly selected. The following points should be noted:

1 The tinnitus must be of the peripheral intrinsic type that has been described.

2 Pronounced degeneration of the acoustic nerve with associated long-standing tinnitus is only occasionally benefited by this type of therapy.

3 Peripheral intrinsic tinnitus associated either with apparently normal hearing or with defective hearing are benefited by this therapy.

4 Peripheral intrinsic tinnitus of one year's duration or less responds best to tympanosympathetic anesthesia.

5 Peripheral intrinsic tinnitus resulting from acute otitis media has not been treated by this method while in the acute stage. However, good results have been obtained during the subsiding stage or in cases of subacute otitis media. Injections are started two weeks after the acute stage.

6 The tympanic membrane may or may not be intact. Peripheral intrinsic tinnitus with or without a history of previous inflammation of the middle ear is amenable to this therapy.

7 Unilateral peripheral intrinsic tinnitus responds best to injection therapy. Bilateral intrinsic tinnitus is usually of central origin and hence does not respond to tympanosympathetic anesthesia.

8 Intractable otalgia from degenerative or ulcerative lesions of the eustachian tubes, nasopharynx, faucial pharynx, tongue, jaws, teeth or nose is benefited by injection of the tympanum.

9 The external auditory canal must be normal, without cellulitis, furunculosis, eczema or other disorder.

10 The vestibular mechanism must be normal as tested by the caloric method.

11 There is no definite age limit. The injection of 4 minims (0.25 cc) of a 5 per cent solution of ethylmorphine hydrochloride is equivalent to 1/6 grain (10 mg) of the drug.

MATERIALS AND METHODS

Tympanosympathetic anesthesia is accomplished by injecting 4 minims (0.25 cc) of a 5 per cent solution of ethylmorphine hydrochloride into the tympanum through the posterior inferior quadrant of the tympanic membrane.

Materials and instruments which are necessary for tympanic injection are a cotton wick, for topical anesthesia of the drum membrane, a 1 ounce (30 cc) bottle of an aniline oil-cocaine solution, a rubber-capped ½ ounce (15 cc) bottle of a sterile 5 per cent solution of ethylmorphine hydrochloride, a 1 cc tuberculin syringe with a no. 22 spinal (Quincke point)* 3 inch (7.6 cm) needle and a magnifying otoscope, or a magnifying lens insert, in a head mirror (fig. 6).

Prior to injection into the middle ear cavity, anesthesia of the ear drum membrane is produced by local application to the tympanic membrane of an aniline oil-cocaine solution (chemically pure aniline oil, 90 parts, cocaine hydrochloride USP, 10 parts) A cotton wick saturated in the aniline oil-cocaine solution is applied to the posterior inferior quadrant of the drum membrane for ten minutes, after removal of the wick, the external auditory canal is wiped dry In order to avoid contamination of the middle ear cavity subsequent to injection, the use of free anesthetic solution in the aural canal is not recommended

The patient lies on a treatment table with the ear to be injected directed upward The head is slightly rotated laterally, so that the eustachian tube of the ear to be treated is directed upward This is done to prevent the escape of the solution from the middle ear through the eustachian tube, into the throat With a 1 cc tuberculin syringe and a no 22 spinal (Quincke point) 3 inch needle, 4 minims of a 5 per cent solution of ethylmorphine hydrochloride is injected into

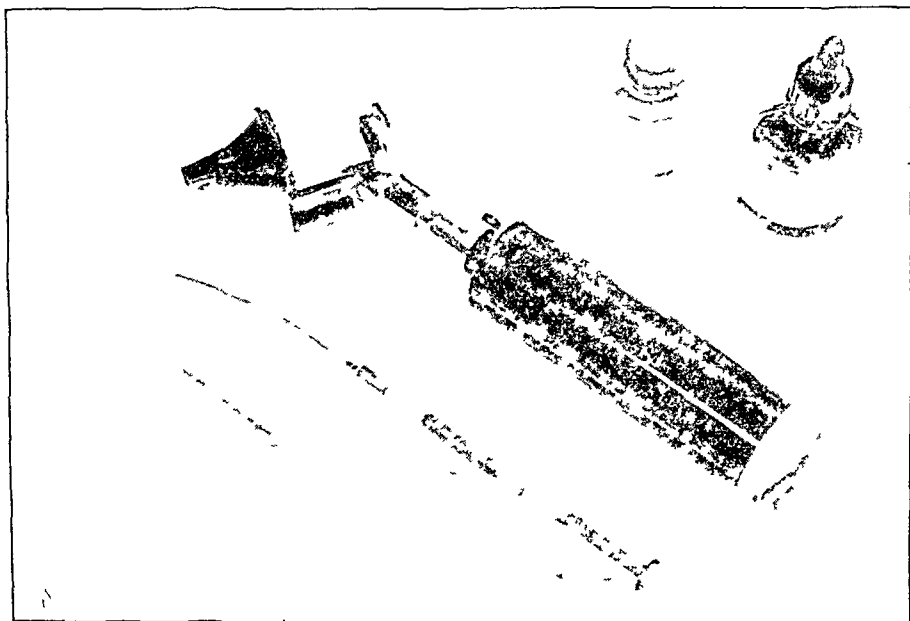


Fig 6—Materials and instruments for tympanic injection

the tympanum through the tympanic membrane just below and posterior to the umbo (fig 7)

The patient maintains his position for five minutes after the injection Occasionally, transient vertigo follows the injection Injection of the tympanum by this method is surprisingly free from uncomfortable or disturbing reactions After the instillation of the solution, relative analgesia occurs, which lasts for hours Patients seldom complain of any painful sensation but, rather, note of a feeling of fulness in the ear Inflammatory changes in the tympanic membrane can be observed within a few minutes after the injection All inflammatory signs subside within four days after the injection

The treatment consists of successive instillations of a 5 per cent solution of the drug at intervals of four days Peripheral intrinsic tinnitus and referred otalgia may be completely, and apparently permanently, abolished in the majority of cases by the injection of 4 minims of the solution on five consecutive four day intervals No definite rule can be made governing the number of injections to be

made, since patients differ in their response to them. Some patients require fewer than five tympanic injections, others, who show only slight improvement after a series of five injections, should be allowed a rest for two months, after which a second series of five injections is given. Some patients have dramatic results, with complete loss of tinnitus or otalgia, while in others, with partial benefit, relief from these annoying symptoms is sufficient to permit normal activity and sleep.

Before beginning injection therapy for tinnitus, an audiometric analysis should be made. A careful audiometric examination is essential to determine the type

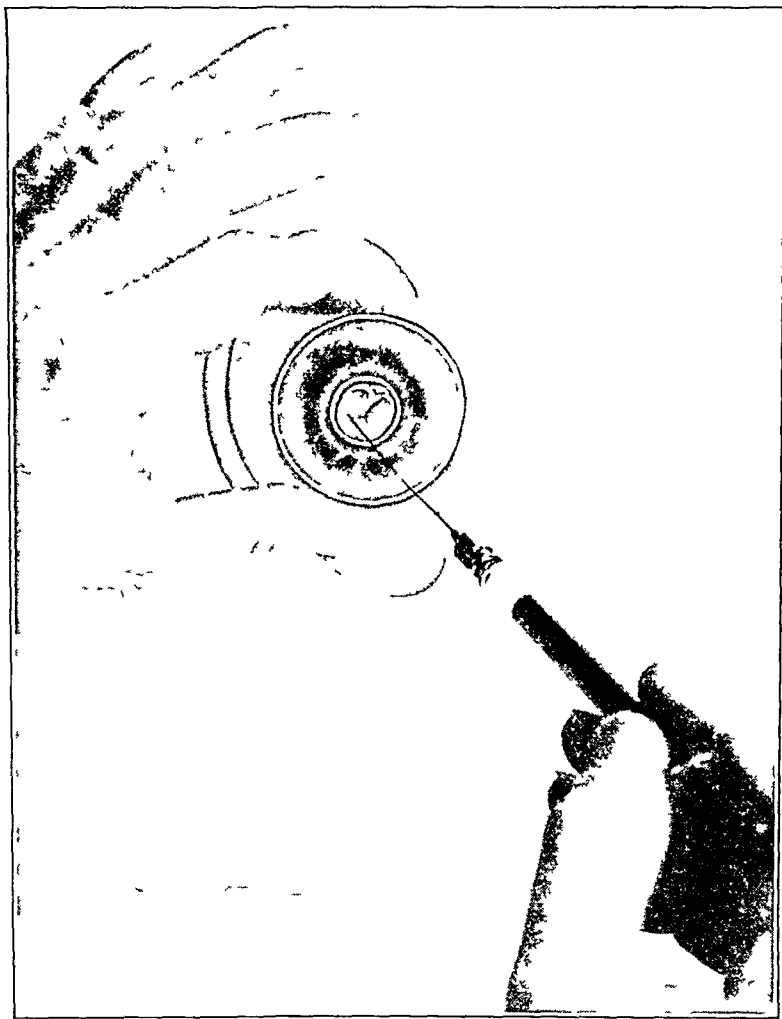


Fig 7—Tympanic injection

and the amount of hearing defect, if present, as well as to aid in the identification of the type of tinnitus⁶. Follow-up audiograms of patients who had injection therapy have shown definite improvements in their hearing⁵. Apparently, there is nothing more effective in decreasing tinnitus than in diminishing deafness. Tympanic injection therapy accomplishes both.

⁶ Trowbridge, B. C. *Electroaudiography: Analysis and Interpretation of the Audiogram*, Arch Otolaryng 35:899 (June) 1942.

RESULTS

Of a series of 20 cases selected for injection of the tympanum to alleviate tinnitus or otalgia, good results were obtained in the majority (table)

In 9 of the cases listed in the table there was not complete loss or cessation of tinnitus or otalgia. However, in the majority of cases

Results of Tympanic Injection in Treatment of Tinnitus Aurium and Secondary Otalgia

Case	Age, Yr	Type of Tinnitus and Pain	Duration	Etiologic Factors	Condition of Drum Head	No of Injections	Results
1	55	Roaring, right	2 wk	Spontaneous onset	Mild catarrh	5	Complete relief
2	44	Ringling, bilateral	4 yr	Gradual onset	Mild catarrh	2	Slight improvement
3	54	Buzzing, bilateral (left, worse)	6 mo	Spontaneous onset	Mild hyperplasia	5	Slight improvement
4	40	Buzzing, left	8 yr	Gradual onset	Hyperplasia	4	Pronounced improvement
5	59	Roaring and intermittent pain, right	12 days	Myringitis bullosa hemorrhagica, right	Lusterless	4	Complete relief, hearing improved
6	61	Crickets sound, right	15 yr	Gradual onset	Mild hyperplasia	5	Tinnitus less severe at night
7	44	Whistling and intermittent pain, right	6 wk	Acute rhinitis	Retraction	3	Complete relief
8	30	Buzzing, right	6 mo	Spontaneous onset	Mild catarrh	1	Complete relief
9	36	Pain, left	1 wk	Abcessed left lower first molar	Mild catarrh	1	Complete relief
10	47	Peanut stand whistle, left	1 wk	Acute rhinitis	Hyperplasia	1	Complete relief
11	33	Ringling, with loss of hearing, left	2 yr	Gradual onset	Hyperplasia	3	Pronounced improvement
12	34	Shooting pain, left	4 days	Post tonsillectomy	Mild catarrh	1	Complete relief
13	41	Cracking, right	4 yr	Frequent infection of upper respiratory tract	Hyperplasia	2	Moderate improvement
14	63	Roaring, with loss of hearing, left	2 wk	Acute recurrent maxillary sinusitis	Adhesive otitis media perforation, healed	3	Complete relief, hearing improved
15	24	Intermittent shooting pain, left	4 days	Extraction of left lower tooth root	Mild catarrh	1	Complete relief
16	19	High pitch tinnitus, left	1 yr	Traumatic rupture of ear drum membrane	Perforation, healed	1	Complete relief
17	68	Sizzling, and steady earache, right	3 mo	Acute rhinitis	Hyperplasia	1	Complete relief, hearing improved
18	25	Buzzing, left	4 yr	Recurrent infection of upper respiratory tract	Adhesive otitis media	3	Moderate improvement
19	65	Singing and intermittent pain, left	25 yr	Gradual onset after tonsillitis	Hyperplasia	3	Tinnitus diminished, pain ceased
20	49	Ringling bilateral	2 mo	Gradual onset	Hyperplasia	6	Moderate improvement, left

the tinnitus was decreased to the point where it was no longer a constant source of annoyance (Most of the patients without complete relief stated that the tinnitus had diminished sufficiently that it did not interfere with their sleep or mental activities) In 2 cases no improvement was obtained In a previously reported series of 22 cases⁵ in which the effect of injection therapy on hearing acuity was primarily studied

improvement in hearing occurred in 18. In 4 cases no improvement was obtained. Of 9 of the cases in which there was associated tinnitus aurium, lessening of the tinnitus occurred in 6 and loss of the tinnitus in 3. The better results obtained in the present cases than in the previously reported series with regard to tinnitus are due to improvements in the technic of injection since the original series was reported.

All the patients were ambulatory and continued their usual daily routines without interference from the injections. Since many patients drove automobiles, the effect of tympanic injection on equilibrium had to be considered. Vertigo rarely occurred after the injections. It was not necessary for the few patients who manifested slight transient vertigo to suspend normal activity, they were able to continue their normal activity after several minutes. Sustained vertigo was not observed in any case. Other secondary reactions were negligible. Acute pain and secondary suppuration of the middle ear did not occur after injection in any case. While there is general reluctance to pierce the intact tympanic membrane, not one case of residual perforation occurred. Closure of the site of injection occurred immediately, with formation of a small, petechia-like blood clot marking the point of injection. An interesting observation which was made independently by Dr. Brownell⁷ and myself was that of the improved appearance of the tympanic membrane after a series of tympanic injections. Hyperplastic and lusterless drums regained their semitransparency and their pearly sheen.

SUMMARY AND CONCLUSION

Injection of the tympanum offers a new approach to the therapy of tinnitus aurium and referred otalgia. While there is not one medical or surgical method that will cure all types of tinnitus, tympanic injection is useful in alleviating peripheral intrinsic tinnitus, the commonest type of tinnitus. In the majority of cases the intensity of tinnitus can be reduced to a point where it is no longer a source of major irritation. Since this minor surgical procedure is directed toward correcting the effect of aural and related lesions, one must not fail to locate and remove, if possible, the cause of the disturbance.

In case 9 of the table are demonstrated the factors of "cause" and "effect" of reflex impulses through the tympanosympathetic plexus. In this case reflex otalgia was initiated by an abscess of the first left lower molar tooth. Otalgia was completely eliminated by one injection of the tympanum. This procedure is not often necessary for this particular cause of otalgia, since the source can be easily located and removed. However, in case 9 is demonstrated the pathway of reflex impulses to the

⁷ M. E. Brownell, M.D., senior resident in otolaryngology, University of Kansas School of Medicine, assisted in the clinical studies.

"trigger" area, the tympanosympathetic plexus, in the middle ear. Injections into the tympanum for referred otalgia arising from ulcerative and degenerative lesions, which are less amenable to direct therapy, give much relief from pain. Since peripheral intrinsic tinnitus is evidently a subthreshold phase of secondary or referred otalgia, the same methods of treatment apply to its relief and removal. The favorable results obtained in the treatment of tinnitus and secondary otalgia by tympanic injection suggest the following classification of tinnitus and its secondary phase of otalgia.

Types of Tinnitus

Extrinsic tinnitus (vibratory)

- (a) Psychoneurotic
- (b) Psychosomatic (menopause)
- (c) True vibratory

Intrinsic tinnitus (nonvibratory)

Peripheral (subthreshold phase)

- (a) Tympanic plexus
- (b) Trigeminal nerve $\left\{ \begin{array}{l} \text{Otic ganglion} \\ \text{Sphenopalatine ganglion} \end{array} \right.$
- (c) Glossopharyngeal nerve
- (d) Carotid sympathetic nerves

Central

- (a) Acoustic nerve to nuclei
- (b) Supranuclear pathways

Secondary otalgia (suprathreshold phase)

Reflex or referred pain

- (a) Tympanic plexus
- (b) Trigeminal nerve $\left\{ \begin{array}{l} \text{Otic ganglion} \\ \text{Sphenopalatine ganglion} \end{array} \right.$
- (c) Glossopharyngeal nerve
- (d) Carotid Sympathetic nerves

Mechanism of Tinnitus and Secondary Otolgia

Initial phase (of minimal irritation)—a subthreshold phase resulting in tinnitus

Secondary phase—a suprathreshold phase resulting in pain

Tympanic injection producing tympanosympathetic anesthesia is a simple and practical procedure for the relief of tinnitus aurium and secondary otalgia in properly selected cases. Aural pain or tinnitus will subside or completely disappear if the trigger zone, the tympanosympathetic plexus, is removed early. By temporarily interrupting the tinnitus or pain reflex pathway, tympanosympathetic anesthesia stops the flow of impulses. No harmful after-effects occur, and side reactions are negligible.

UVULA AND TONSILS

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THE QUESTION of what role the uvula plays under normal conditions has stimulated the interest of many laryngologists. Yet only a few answers, and these tentative, have been given in the past.

A paper by Richardson and Pullen,¹ recently published in these ARCHIVES, attributed so many physiologic functions to the uvula that it seems to be a very important organ of the human body. However, it remains to be seen whether further observations will prove that the conclusions drawn by Richardson and Pullen from their experience are entirely justified. They concluded that the uvula massages and moistens the posterior pharyngeal wall and aids in removing and moving downward material from this wall, that it transfers the secretion from the midline of the velum and the posterior pharyngeal wall from above and anteriorly to the midline posteriorly, that it is a valuable aid in guarding against middle ear disease in children and that, by preserving the normal pharyngeal arches, it prevents pharyngitis sicca, with subsequent drying of the eustachian orifice. A deviation of the uvula to one side may indicate weakness of the accessory nerve on the other side. According to these authors, the uvula prevents rhinolalia aperta (hyperrhinolalia) as a complication of successful tonsillectomy. In my opinion this statement is tenable only under exceptional conditions, namely, if the soft palate is so short that it can reach the posterior wall of the pharynx only by using its entire length and the uvula. In this case the uvula may partly fill the gap between the pharyngeal raphe and the contracted constrictor fibers. But, since the uvula is either oval or conic while the gap is angular, the uvula will not always fill the space. Furthermore, it has been proved that there may be a maximum distance of 3 mm between the posterior pharyngeal wall and the soft palate without hyperrhinolalia being present. If the soft palate is not abnormally short, there is, as is well known, a part hanging down even if the soft palate rises to touch the posterior wall of the pharynx. The part hanging down is the perpendicular part, and it is this portion to which the uvula is attached. The perpendicular part, however, neither creates nor prevents hyperrhinolalia.

1 Richardson, G. S., and Pullen, E. M. The Uvula, Arch Otolaryng 47 379-394 (April) 1948

Normal, as well as abnormal, conditions of the uvula may help in determining the physiologic role or roles of that organ. I presume that it is well known to many laryngologists that the uvula shrinks after tonsillectomy. I have devoted several studies to this occurrence and have published the results.² My first article was based on an observation on only 75 patients. Since then I have examined hundreds of patients, some of them both before and after the tonsillectomy, and

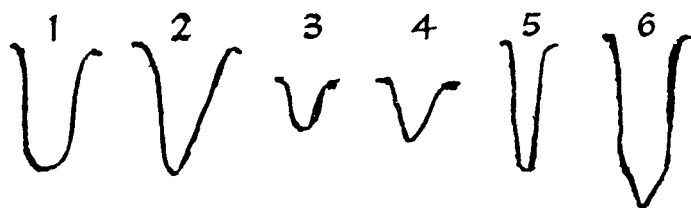


Fig. 1—Six types of the normal uvula

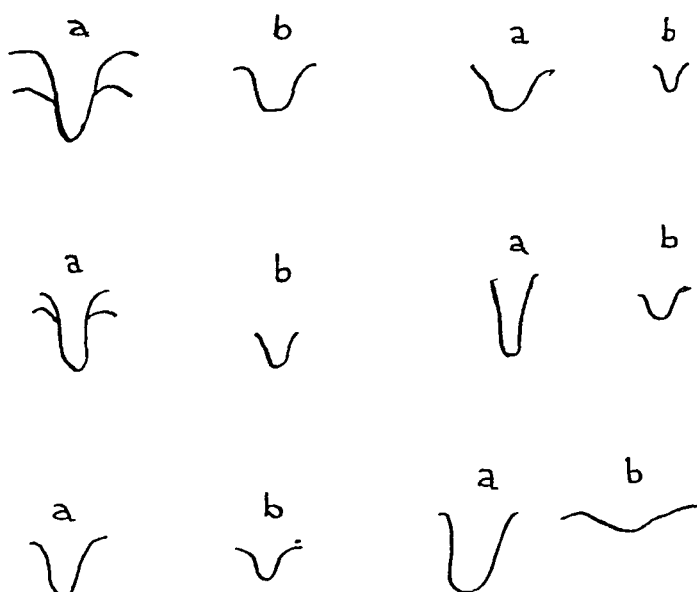


Fig. 2—Uvulas before and from two to three weeks after operation

others only after the operation. All these observations have confirmed my former findings.

The uvula under physiologic conditions may present one of six types, as shown schematically in figure 1. Of 278 normal uvulas, 157 belonged to type 1, 46 to type 2, 56 to type 3, 8 to type 4, 8 to type 5 and 3 to type 6. Of 250 persons with tonsils removed, only 14 showed type 1, 8 type 2, 11 type 3 and the rest type 4. In all patients the

² Froeschels, E. Ueber das Schicksal des Zapfchens nach Entfernung der Gaumenmandeln, *Monatsschr. f. Ohrenh.* 69 155-158, 1935.

uvula had the normal form of its respective type but was smaller. No fixed relation could be found between the size before and that after the operation. Frequently, a very large uvula shrinks to a very small one, but in rare cases the reduction in size is not great. Yet some shrinkage was noticeable in all of the patients observed before and after tonsillectomy. Even if one has not had an opportunity to observe a patient before tonsillectomy, the uvula afterward is so conspicuously short, and frequently so thin, in the great majority of cases that one is inclined to assume a reduction in size. Sometimes the edges of the

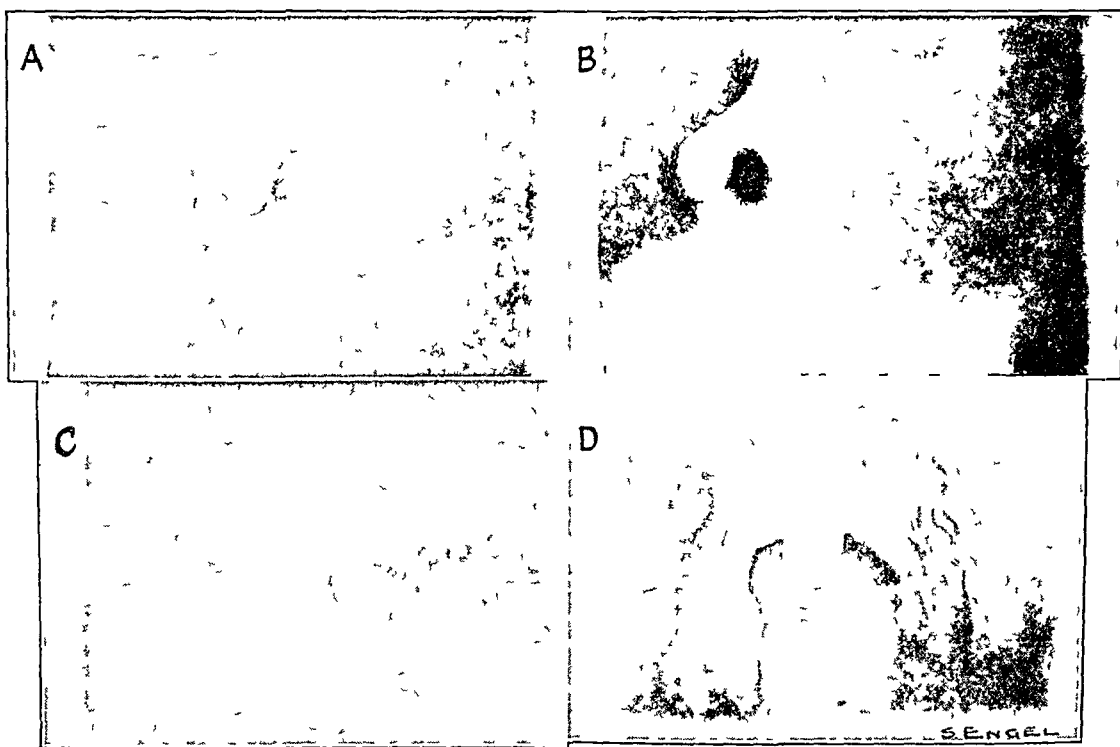


Fig 3—*A*, photograph of an uvula before operation, *B*, the same uvula after operation, *C*, uvula of a cadaver with tonsils removed, *D*, arches and uvula of a cadaver with tonsils

uvula are almost transparent, a condition which to my knowledge does not occur under normal conditions.

In my first publication on this subject I stated that it is hard to determine just how long after the operation the shrinking began because the usual swelling in the region of the faucial arches hinders clear judgment. It was stated in this article that two weeks after the operation the diminution in size was visible in every case. Later, in several cases, I had the opportunity of seeing the uvula three or four days after tonsillectomy. In these cases the edges were discolored and sometimes looked almost transparent. Yet it was impossible to decide whether edema or diminution of the normal tissue or both were

responsible for the peculiar appearance. One case suggested the possibility that the shrinking process may last a long time. A woman reported to me that since her tonsils had been removed, four years before, her uvula had been getting progressively smaller.

Figure 2 shows sketches of 6 uvulas before and from two to three weeks after the operation. *A* and *B* of figure 3 present photographs of a uvula before and after tonsillectomy.³ *C* and *D* of figure 3 are photographs of the uvula and arches of 2 cadavers. Figure 3 *C* shows a cadaver with tonsils removed, *D*, the uvula of a cadaver with the tonsils not removed. The uvula in figure 3 *C* is so small that the size can be attributed to the shrinking after tonsillectomy, although no comparison with its preoperative size can be offered.

Histologic examination of 4 uvulas from cadavers with tonsils removed showed that no real atrophy was present and that none of the normal tissue was missing or reduced out of proportion as compared with other physiologic tissue of the organ. In other words, histologically, a shrunken uvula looks exactly like a normal uvula of the same size.

It is not certain that decrease in size is due to the diminution in circulation of blood caused by scar formation, for the blood supply derives partly from arterial branches coming from the tonsillar region to the soft palate and partly from the sphenopalatine artery (anterior supply). Furthermore, persons with visible and severe scars in the arches do not show particularly small uvulas.

Not enough is known about the functions of the tonsils. Only recently Šercer and Ruždić⁴ published a paper on the sugar-fermentative function of the tonsils. Perhaps the tonsils are not without influence on the metabolism of neighboring organs.

Two practical conclusions may be drawn from the observations described: first, that tonsillectomized persons offer an excellent opportunity for comparison of the functions of normal uvulas and those of shrunken uvulas, second, that in cases—certainly rare—in which there is an indication for tonsillectomy and for clipping the uvula, the latter may be postponed until the shrinking of the uvula has taken place, thus making the clipping superfluous.

133 East Fifty-Eighth Street (22)

³ Unfortunately, one side of the pharynx is invisible, but different sizes of the uvula are well recognizable.

⁴ Šercer, A., and Ruždić, J. Beiträge zur Kenntnis der fermentativen Tätigkeit der Tonsillen, *Acta oto-laryng* **36** 236-249, 1948.

Case Reports

PERFORATION OF THE ESOPHAGUS BY A THUMB TACK AND SUBSEQUENT REMOVAL BY AN ELECTROMAGNET

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The following case report is considered of interest because mediastinitis following perforation of the esophagus by a foreign body was treated successfully and because the foreign body was removed by means of an electromagnet

REPORT OF CASE

The patient, a 10 year old boy, was admitted to the hospital at 6 p m, April 18, 1947 At 2 45 p m that day he had swallowed a thumb tack His only complaint was that of a sensation of something sticking in his throat Physical examination was noncontributory

Lateral and anteroposterior roentgenograms of the neck (fig 1A) revealed the outline of a thumb tack lodged in the anterior wall of the esophagus at the level of the sixth cervical vertebra The shaft of the tack was directed anteriorly and slightly to the right of the midline

Soon after admission, with the patient under ether anesthesia, the esophagus was explored with an esophagoscope As no evidence of the tack could be found after a thorough search of the hypopharynx and the entire length of the esophagus, roentgenograms were taken with a portable machine The wet films did not reveal the foreign body Figure 1B shows that the tack was discernible on later examination, after the films were processed and dried

Penicillin therapy (30,000 units of penicillin every three hours) was instituted on the patient's return to his room

The following morning the child appeared to be ill The respiratory rate was 20 per minute, the pulse rate, 80, and the rectal temperature, 101 F Roentgenologic examination at this time disclosed that the tack was in the esophagus and that the head of the tack had become separated from the shaft (fig 1C) The shaft was at the level of the third thoracic vertebra, with the point of the tack directed anteriorly and slightly to the right of the midline The head of the tack was at the level of the sixth thoracic vertebra It ultimately passed through the gastrointestinal tract An area of increased density in the upper part of the middle lobe of the right lung was noted

The patient was having some dysphagia By noon the rectal temperature had risen to 102 F, the pulse rate to 96 and the respiratory rate to 24 Respirations were of the grunting type The leukocyte count was 18,750 per cubic millimeter of blood, with 88 per cent neutrophils, and the concentration of hemoglobin was 13.5 Gm per hundred cubic centimeters At this time the child complained that he was having increased difficulty with swallowing and that he had pain in the lower right side of his neck Physical examination revealed a slight swelling at the base of the neck on the right side in the supraclavicular area Roentgenograms taken at this time (three hours subsequent to that in fig 1C) revealed that the pulmonary area of density in the middle lobe of the right lung had

increased. An area of widening of the hilus toward the right was also noted. Otorhinolaryngologic and surgical consultants decided on supportive treatment, chemotherapy and use of antibiotics. Administration of penicillin was continued on a three hour schedule with increased dosage (100,000 units for the first two doses and 50,000 units thereafter). Intravenous administration of sodium sulfadiazine was begun (0.5 Gm. every four hours).

For the next two days the child was ill, even irrational at times, and the pain he complained of previously persisted. In the region of pain were swelling, tenderness and induration. Fever was of the septic type, with the rectal temperature rising to 103 F. The pulse rate was 100. The respiratory rate was 26, and respirations continued to be of the grunting type. The leukocyte count decreased to 12,700, with 82 per cent neutrophils. Roentgenologically the position of the shaft of the tack was not changed, but the width of the mediastinum had increased one and a

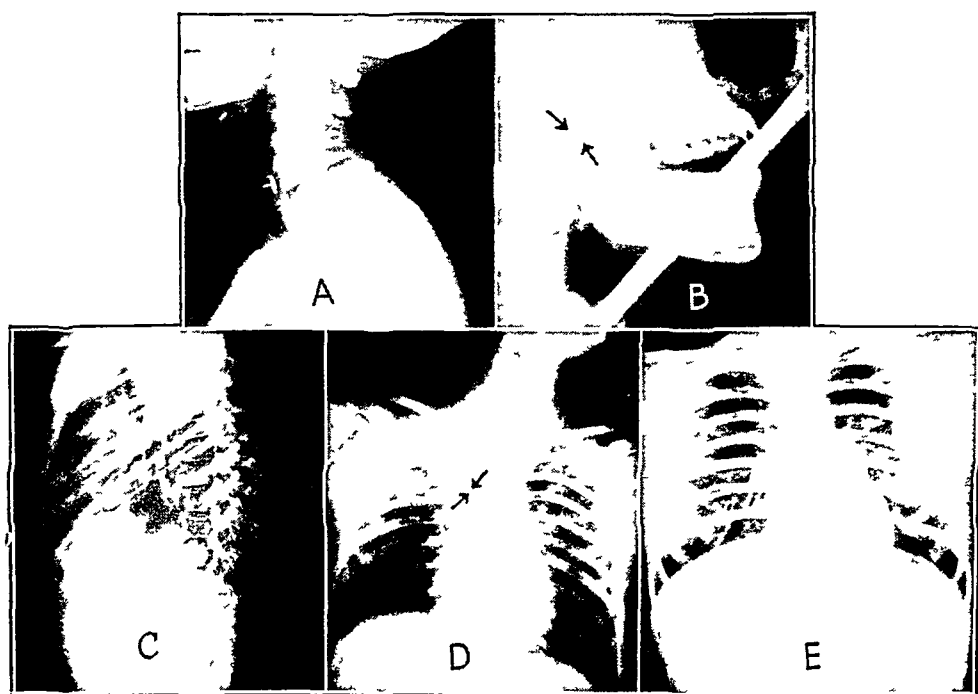


Fig 1—*A*, lateral roentgenogram taken on the patient's admission, *B*, roentgenogram at time of esophagoscopy, *C*, roentgenogram taken twelve hours later, on following morning, *D*, anteroposterior view, showing increase in width of mediastinum, *E*, roentgenogram of chest on nineteenth postoperative day.

half times its normal size (fig 1*D*). A zone of density, corresponding to gas, extended superiorly from the level of the tack shaft.

On the fourth day the patient was more alert, complained less of pain and took large quantities of fluid by mouth without difficulty. However, the swelling at the base of the neck on the right side increased. There was increase in the temperature and in the pulse and respiratory rates. The leukocyte count decreased to 10,000, with 89 per cent neutrophils. The mediastinum was widened further. In the lateral view the major portion of this area of increased density appeared to be located posteriorly, but also extended anteriorly.

In the next two days, his fifth and sixth days in the hospital, clinical improvement continued. The swelling at the base of the neck increased and evidenced

beginning fluctuation. A roentgenogram showed a definite extension of the mass in the right side of the mediastinum. In the lateral view there appeared to be some compression of the lower portion of the trachea.

On the seventh day, with the patient under intratracheal nitrous oxide-oxygen and ether anesthesia, a 4 inch (10 cm) vertical incision was made parallel to the sternocleidomastoid muscle on the right over the neurovascular bundle. The latter was retracted laterally, the middle thyroid vein and inferior thyroid artery were ligated, the lobe of the thyroid was retracted medially and the dissection was carried medially and inferiorly. An abscess cavity was entered at about the level of the suprasternal notch between the cervical vertebrae and the esophagus.

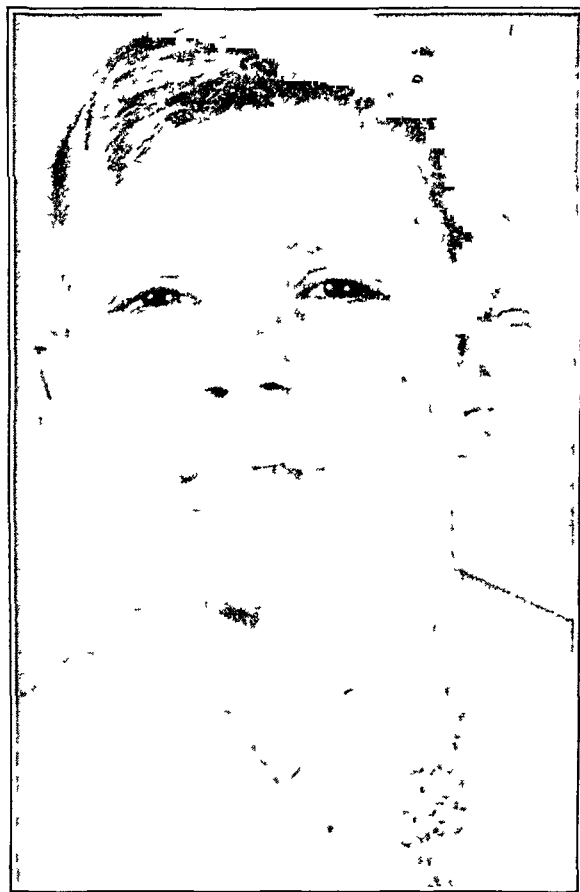


Fig 2—Patient four months after operation. There is a birthmark in the left sternoclavicular area.

Approximately 200 cc of white, gelatinous, odorless fluid was released from this cavity in the mediastinum. Similar material was, at the same time, aspirated from the mouth by the anesthetist, an indication that there was simultaneous drainage of the abscess through the esophagus.

Two Penrose drains were inserted into the base of the abscess cavity and were anchored at the edge of the wound.

Culture of the aspirated material gave a scanty growth of a hemolytic streptococcus and an abundant growth of nonhemolytic *Staphylococcus aureus*.

Postoperatively, water taken by mouth streamed through the wound in the neck, with frothy saliva. Intravenous supportive treatment was instituted. On the sixth

postoperative day a Levin tube was passed through the nose to the stomach for feeding, and two days later fluid ceased to drain through the incision in the neck.

Laryngoscopic examination revealed that the right vocal cord was fixed slightly lateral to the midline.

Recovery was uneventful, and the temperature rapidly fell by lysis. A roentgenogram on the sixth postoperative day showed that the mediastinal shadow had definitely decreased. The lateral view revealed the shaft of the tack to be in the mediastinum posterior to the esophagus, as outlined by the Levin tube.

On the ninth postoperative day, with the aid of a fluoroscope, a flexible laryngeal forceps was passed through the wound in the neck to the bottom of the abscess cavity. The shaft of the tack appeared to be only a few millimeters from the tip of the forceps. A large electromagnet was then attached to the forceps, and shortly thereafter the point of the tack appeared to be in contact with the side of the forceps. The forceps was then slowly withdrawn with the shaft of the tack attached.

The wound ceased to drain three days later. A roentgenogram on the nineteenth postoperative day disclosed little residual evidence of the episode (fig 1E).

Examination of the larynx four months later indicated that mobility of the right vocal cord was restored. Swallowing was normal, roentgenographic studies with barium sulfate showed no abnormalities, and the wound in the neck was closed (fig 2).

COMMENT

The complications in this case—the change in position of the tack, the separation of the head from the shaft and the injury of the recurrent laryngeal nerve—as well as the subjective improvement under treatment with penicillin and sulfadiazine, are of interest.

On the day the patient was admitted to the hospital, the foreign body could not be found in the course of a thorough esophagoscopy examination, nor was it evident in the roentgenograms taken at the time. However, the nasopharynx was not examined. It seems likely, then, that the tack was regurgitated into the nasopharynx during the induction phase of anesthesia and was lodged there during esophagoscopy. In the recovery phase of anesthesia the tack was again swallowed and separated, the shaft penetrating the esophagus and the round head passing on through the gastrointestinal tract. The faint outline of the tack could be seen after the films taken with the portable machine were passed through the dryer (fig 1B).

Sodium sulfadiazine and penicillin produced subjective improvement and decrease of the leukocyte count, however, mediastinitis progressed, as evidenced by fever and abscess formation.

Injury of the recurrent laryngeal nerve during drainage of the mediastinal abscess resulted in transient paralysis of the right vocal cord. At examination of the larynx two months later function of the right vocal cord was found to have returned completely.

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Clinical Notes; New Instruments and Technics

IMPROVED METHOD OF APPLYING A MEDICINAL SOLUTION TO THE MIDDLE MEATUS OF THE NASAL CHAMBER

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THE ADMINISTRATION of nasal medication usually has in view two objectives—first, shrinkage of the congested mucous membrane with the aim of restoring proper nasal breathing, and second, shrinkage of the region of the ostia of the sinuses with the purpose of establishing drainage. The problem of eradicating infection at its site is not considered in this paper.

"Before nasal medication can attain maturity, a number of perplexing problems require solution" (Fabricant¹). The question how to deliver a medicinal solution to those areas of the nasal chamber where it will be most effective is frequently asked by the practicing physician, and the problem raises a number of pertinent considerations.

If one looks at the base of the nose without using a nasal speculum, only raising the lobule with a finger, one will notice the columella and the nasal septum in the midline and in the nostril laterally the bulging head of the inferior turbinate, also, the inferior meatus and part of the floor of the nose may be seen. However, in most cases it is impossible to see the middle turbinate or the middle meatus. These anatomic parts of the nasal cavity are hidden by the upper lateral cartilage, the caudal end of which projects into the vestibule as a significant landmark. Several authors call this line by different names—the *limen nasi* or the *plca vestibuli*.

Figure 1, a drawing of the lateral nasal wall, shows the *limen nasi* (*a*). This important landmark runs from a point in the nasal tip just behind the caudal end of the septal cartilage laterally toward the attachment of the inferior turbinate. If one intends to administer a medicinal solution to the middle meatus, it seems evident that the tip of the applicator should be placed behind and above the *plca vestibuli*.

The inferior meatus plays no important role in nasal medication, since the sinus openings are situated in the middle and superior meatuses. The maxillary sinus, the anterior ethmoid cells and the frontal sinus drain into the middle meatus. Figure 1 shows these sinus ostia in the lateral nasal wall. The posterior ethmoid cells and the sphenoid sinus communicate with the superior meatus. The ostium of the maxillary sinus is located above the level of the floor of the sinus and cannot drain in the erect position of the head. The ostium of the frontal sinus and that of some grooves of the ethmoid sinus point downward and favor natural drainage. Therefore, in cases of acute and chronic sinusitis it is

From the Department of Otolaryngology of the New York Polyclinic Medical School and Hospital.

1 Fabricant, N. D. Nasal Medication, Baltimore, Williams & Wilkins Company, 1942.

the middle meatus which should be reached by local nasal medication. However, most applicators used do not serve the purpose.

Figure 1 demonstrates the possible direction of the flow of fluids in the nose. Arrows point to the inferior (*a*) and the middle (*b*) meatus. Fluid administered to the inferior meatus often drains backward along the floor of the nasal cavity into the pharynx. In other cases fluid runs out of the nostril in which the applicator is located, and is thus inefficiently administered. Frequently, in order to help the fluid reach the middle meatus, the patient is required to assume an awkward position and perform irksome gymnastics. Parkinson² recommended the head-low posture to enable medication to reach the ostiums of the nasal sinuses.

To overcome these drawbacks, I attempted to construct an applicator which would permit the administration of nasal medication directly to the middle meatus and which could be used easily and comfortably by adults and children.

Figure 2 *A* is an illustration of the new applicator. The letter *a* indicates the body portion of the applicator and *b* the nozzle, or outlet portion, while *c*

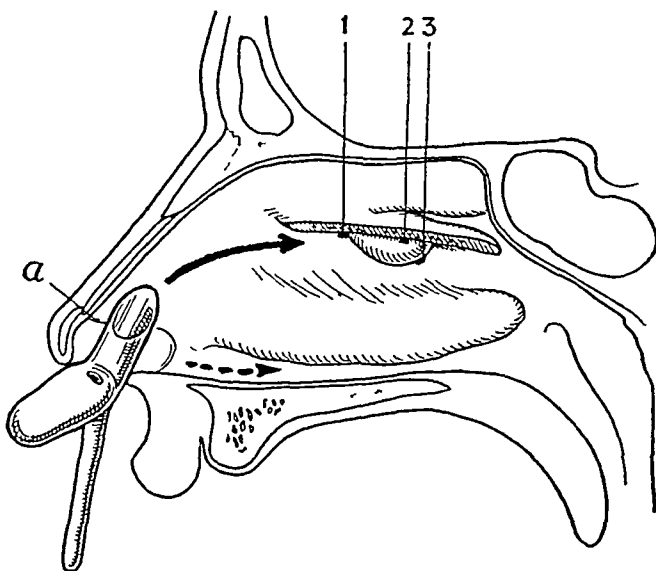


Fig 1—Drawing of a sagittal section of the nose. The middle turbinate bone has been removed, exposing the sinus openings. 1, ostium frontale, 2, ostium ethmoidale, 3, ostium maxillare. The drawing also shows the position of the applicator, the opening of which can be seen above the limen nasi (*a*).

indicates the handle by which the applicator is conveniently manipulated. The body portion (*a*) provides a chamber in which the fluid to be administered is contained, the same being delivered into the interior of the body through the open end (*d*), out of which it is also delivered into the middle meatus.

It is to be noted that the upper edge of the nozzle (*b*) is slanted or inclined, thus providing the nozzle with a sidewall (*e*) that is higher than the opposite wall (*f*). The top wall of the body (*a*) is provided with a small hole, or air vent (*g*).

The operation of the new applicator will be readily comprehended from figure 2 *B* and *C*. The number of desired drops is delivered to the body through the

² Parkinson, S. N. A Lateral Head-Low Position for Nasal and Sinus Treatment, *Arch Otolaryng* 17 787 (June) 1933

opening (d) with an ordinary nasal dropper or by being poured through the opening. The applicator is held substantially horizontally in the hand by the stem (c), and the nozzle portion (b) is inserted into the nostril near the tip of the nose above the plica vestibuli. In inserting the nozzle (b) the longer wall portion (e) of the nozzle should be directed toward the upper cartilaginous

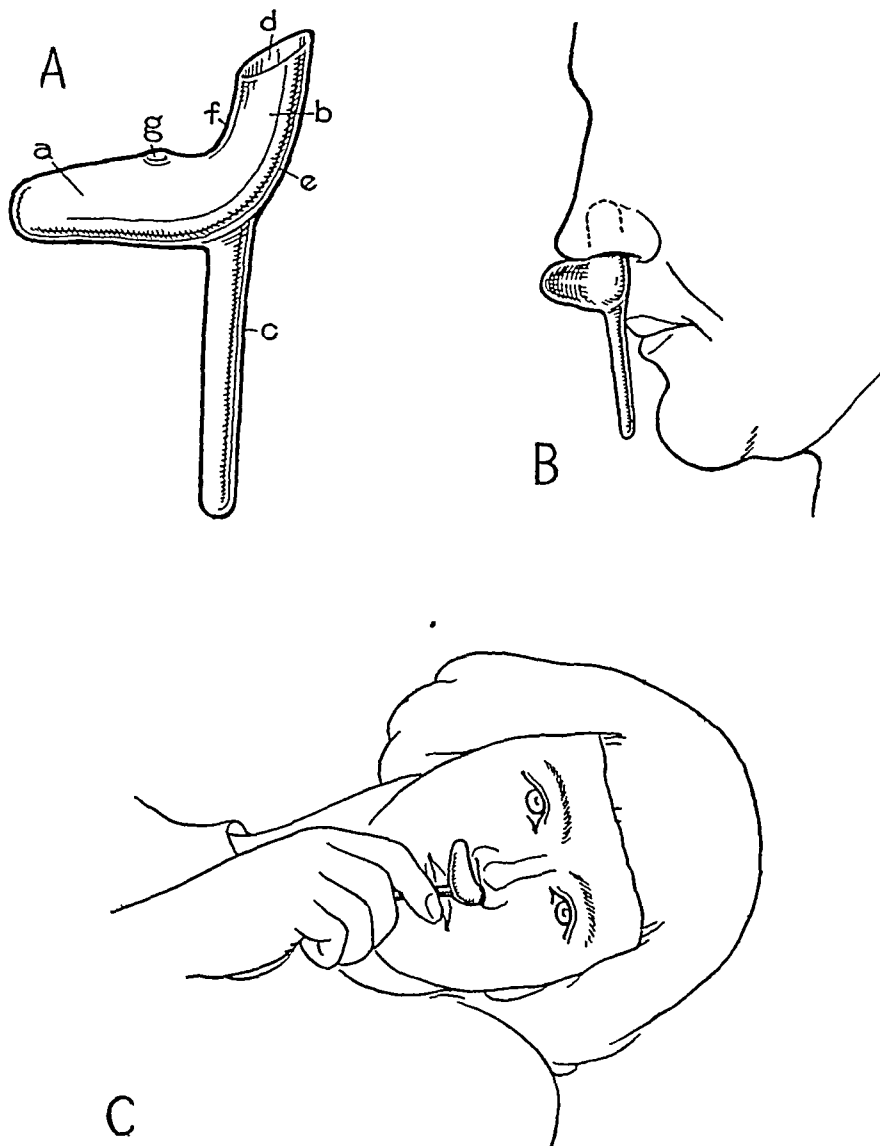


Fig 2—A, diagram of the tilt applicator (a) body portion, (b) nozzle, (c) handle, (d) open end, (e) higher side wall, (f) opposite lower side wall, (g) air vent

B, the position of the head with the applicator installed

C, the tilting of the head toward the shoulder to release the fluid from the applicator into the middle meatus

vault, i e, the lateral wall of the external nose, and the short wall (f) of the nozzle should be located toward the nasal septum

By placing a finger on the outside of the external nose, one can feel the exact position of the tip of the applicator. Figure 1 shows this position in relation to

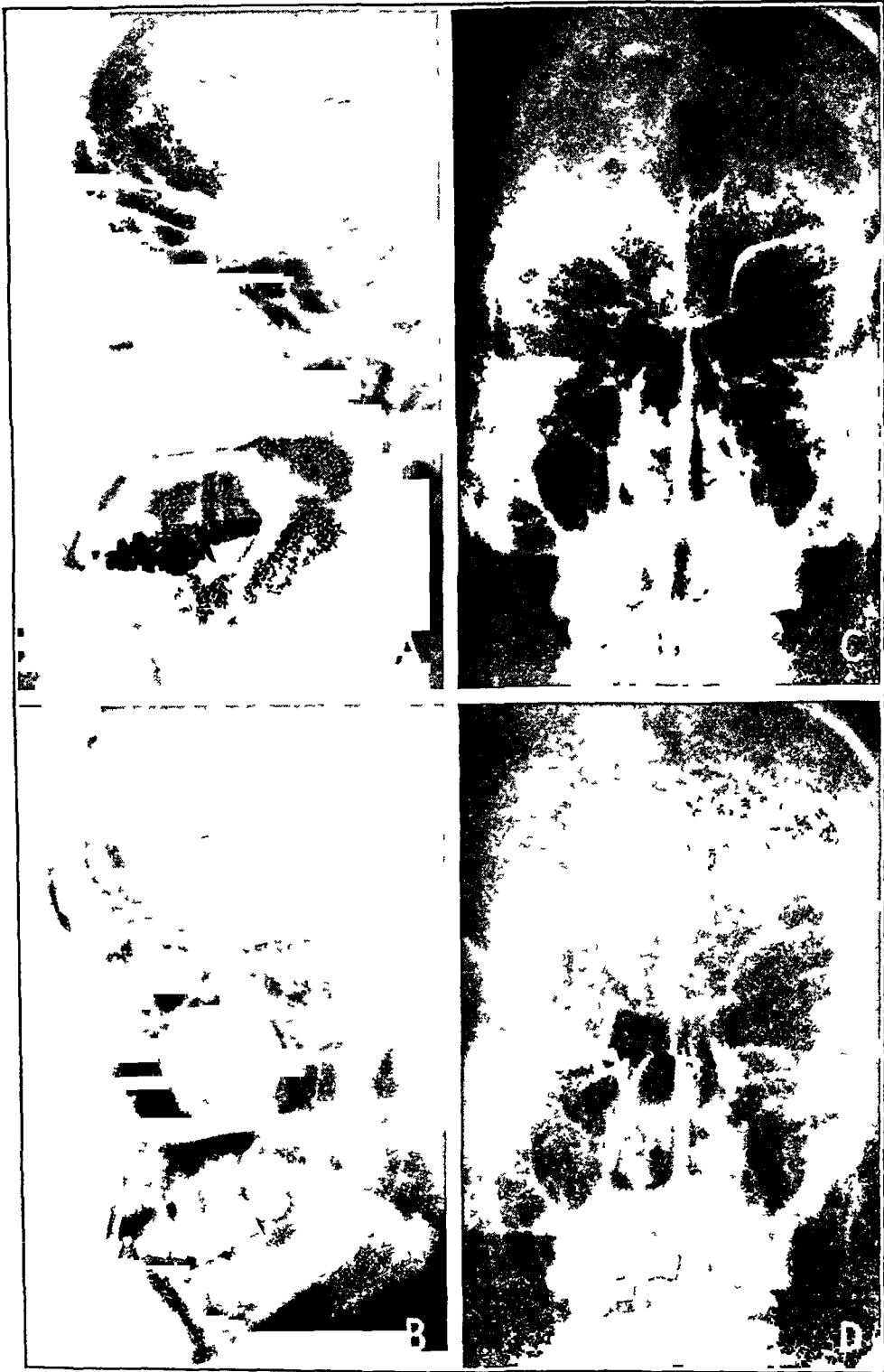


Fig 3—Roentgenograms taken before and after instillation of iodized poppy-seed oil 28 per cent *A* and *C* were taken ten minutes after administration of a vasoconstrictor and before instillation of the iodized oil *B* and *D* were taken after instillation of the oil *D* was taken five minutes before *B*

the lateral nasal wall. The position of the opening of the applicator can be seen above the limen nasi, directed toward the middle meatus. The body portion (*a*) of the applicator extends crosswise below the columella.

Holding the applicator so applied, the patient's head (fig 2 *B*) is first tilted slightly forward and downward and then (fig 2 *C*) to the side toward one shoulder, with the nasal tip held slightly upward to cause the liquid contents of the applicator to flow readily out of the open end (*d*) of the nozzle tube into the middle meatus. The handle (*c*) allows leverage to be applied to the applicator, aiding the patient to determine quickly the proper inclination of the head required to deliver the liquid into the middle meatus. The medicinal fluid remains in the infundibulum, which acts like a gutter. There is no overflowing into the pharynx or out of the nostril if moderate amounts of fluid are used.

As a final step, the patient's head is brought face downward for the purpose of permitting the medicinal solution to flow out again.

That the solution can be easily delivered into the middle meatus and into the infundibulum by this method was evidenced by a series of roentgenograms, taken in each instance before and after the instillation of iodized poppyseed oil 28 per cent into the nasal cavity by means of the new tilting applicator. These roentgen films were made with the patient lying in a lateral position on the table, with the nostril to be treated downward. In most cases there was no premedication with vasoconstrictors or any other drugs.

One patient received a premedication of 5 drops of 0.25 per cent phenylephrine hydrochloride N N R (neo-synephrine hydrochloride®) delivered with the tilt applicator into the right nostril in order to shrink down the mucous membrane of the middle meatus.

The roentgenograms are shown in figure 3. Figure *A* and *C* were taken ten minutes after the administration of the vasoconstrictor and before the instillation of 0.5 cc of iodized poppyseed oil 28 per cent. *D*, was taken five minutes before *B* was made.

For more than five minutes the oil seems to have remained in the area of the middle meatus. The inferior meatus does not show any trace of the oil. The same result was achieved by the administration of 1 cc of iodized poppyseed oil 28 per cent to the right nostril in a number of cases.

SUMMARY

Evidence is presented to demonstrate that an oily or aqueous medicinal solution may be introduced into the middle meatus and into the infundibulum by means of a specially designed nasal applicator. The administration of the solution can be carried out by the patient or by the physician simply, quickly and comfortably, as it requires only the instillation of the tilt applicator and a lateral inclination of the head.

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Special Reports

HEARING AIDS ACCEPTED BY THE COUNCIL ON PHYSICAL MEDICINE AND REHABILITATION, THE AMERICAN MEDICAL ASSOCIATION

As of June 1, 1949

Acousticon Model A-100 Mfr Dictograph Products, Inc 580 Fifth Avenue New York 19	J A M A 138 293 (Sept 25) 1948
Aurex (Semi-Portable)	J A M A 109 585 (Aug 21) 1937
Aurex Model C-B and Model C-A	J A M A 120 535 (Oct 17) 1942
Aurex Model F	J A M A 138 294 (Sept 25) 1948
Aurex Model H Mfr Aurex Corporation 1117 North Franklin Street Chicago	J A M A 136: 1099 (April 24) 1948
Beltone Mono-Pac	J A M A 130: 637 (March 9) 1946
Beltone Harmony Mono-Pac Mfr Beltone Hearing Aid Company 1450 West Nineteenth Street Chicago	J A M A 133: 543 (Feb 22) 1947
Dysonic Model 1 Mfr Dynamic Hearing Aids, Inc 1042 Atlantic Avenue Brooklyn 16	J A M A 137 1534 (Aug 21) 1948
Electroear Model C Mfr American Earphone Company, Inc 10 East Forty-Third Street New York 17	J A M A 136 769 (March 13) 1948
Gem Hearing Aid Model V-35 Mfr Gem Ear Phone Company, Inc 50 West Twenty-Ninth Street New York 1	J A M A 139 229 (Jan 22) 1949
Maico Type K	J A M A 129• 32 (Sept 1) 1945

Maico Atomeer Mfr The Maico Company, Inc North Third Street Minneapolis 1	J A M A 133.542 (Feb 22) 1947
Mears Aurophone Model 200 1947-Mears Aurophone Model 98 Mfr Mears Radio Hearing Device Corporation 1 West Thirty-Fourth Street New York 1	J A M A 138.428 (Oct 9) 1948 J A M A 137 1535 (Aug 21) 1948
Micronic Model 101 (Magnetic Receiver) Mfr Micronic Company 727 Atlantic Avenue Boston 11	J A M A 139 99 (Jan 8) 1949
Microtone T-3 Audiomatic Microtone T-4 Audiomatic Microtone T-5 Audiomatic Mfr The Microtone Company Ford Parkway on Mississippi St Paul 5	J A M A 138 1229 (Dec 25) 1948 J A M A 136 109 (Jan 10) 1948 J A M A 139.379 (Feb 5) 1949
National Cub Model National Standard Model National Star Model Mfr National Hearing Aid Laboratories 815 South Hill Street Los Angeles 14	J A M A 138 295 (Sept 25) 1948 J A M A 138 295 (Sept 25) 1948 J A M A 138 295 (Sept 25) 1948
Otarion, Model A-1 Otarion, Model A-3 Otarion, Models A-4 J & S Otarion, Model E-1 Otarion, Model E-1S Otarion, Model E-2 Otarion, Model E-4 Mfr Otariion Hearing Aids 159 North Dearborn Street Chicago	J A M A 115 1101 (Sept 28) 1940 J A M A 132 1071 (Dec 28) 1946 J A M A 132 925 (Dec 14) 1946 J A M A 136 108 (Jan 10) 1948 J A M A 138 650 (Oct 30) 1948 J A M A 138.887 (Nov 20) 1948 J A M A 140 156 (May 14) 1949
Paravox Model XT Paravox Model XTS Paravox Models VH and VL	J A M A 132 79 (Sept 14) 1946 J A M A 134 365 (May 24) 1947 J A M A 136 109 (Jan 10) 1948

- Paravox Model Y (YM, YC
and YC-7) J A M A 140 155 (May 14) 1949
Mfr Paravox, Inc
2056 East Fourth Street
Cleveland 15
- Precision Table Hearing Aid J A M A 139 785-6 (Mar 19) 1949
Mfr Precision Electronics
Company
850 West Oakdale Avenue
Chicago 14
- Radioear Model 45-CM J A M A 126 1151 (Dec 30) 1944
- Radioear Model 45-M-magnetic
air conduction receiver J A M A 127 219 (Jan 27) 1945
- Radioear Model 45-M-magnetic
bone conduction receiver J A M A 127 27 (Jan 6) 1945
- Radioear Permo-Magnetic
Uniphone J A M A 139. 787 (March 19) 1949
- Radioear Permo-Magnetic
Multipower Report not yet published
Mfr E A Myers & Sons
306 Beverly Road
Mount Lebanon
Pittsburgh
- Ravox (Semi-Portable) J A M A 113 18 (Oct 28) 1939
Mfr Zenith Radio Corporation
6001 West Dickens Avenue
Chicago
- Silver Micronic Hearing Aid,
Model 101 J A M A 135 159 (Sept 20) 1947
- Silver Micronic Hearing Aids
Models 202M & 202C J A M A 139. 848 (March 26) 1949
Mfr Micronic Company
727 Atlantic Avenue
Boston 11
- Sonotone Audicles Nos 530
531 and 533 J A M A 123 837 (Nov 27) 1943
- Sonotone Model 600 J A M A 131. 523 (June 8) 1946
- Sonotone Model 700 J A M A 135 838 (Nov 29) 1947
- Sonotone Model 900 J A M A 139 786 (March 19) 1949
Mfr Sonotone Corporation
Elmsford, N Y

- Superfonic Hearing Aid J A M A 138 293 (Sept 25) 1948
 Mfr American Sound
 Products Inc
 2454 South Michigan Avenue
 Chicago
- Televox Model E Report not yet published
 Mfr Televox Mfg Company
 117 South Broad Street
 Philadelphia 7
- Telex Model 22 J A M A 134 605 (June 14) 1947
- Telex Model 97 J A M A 138 294 (Sept 25) 1948
- Telex Model 612 J A M A 114 1634 (April 27) 1940
- Telex Model 900 J A M A 117 1978 (Dec 6) 1941
- Telex Model 1020 J A M A 117 2072 (Dec 13) 1941
- Telex Model 1550 J A M A 126 705 (Nov 11) 1944
 Mfr Telex, Inc
 Minneapolis 1
- Tonemaster Model Royal J A M A 139 848 (March 26) 1949
 Mfr Tonemasters, Inc
 1627 Pacific Avenue
 Dallas 1, Texas
- Trimm Vacuum Tube Model 300 J A M A 133 542 (Feb 22) 1947
 Mfr Trimm, Inc
 400 West Lake Street
 Libertyville, Ill
- Unex Model A J A M A 134 254 (May 17) 1947
 Mfr Nichols & Clark
 Hathorne, Mass
- Vacolite Model J Report not yet published
 Mfr Vacolite Company
 3003 North Henderson Street
 Dallas 6, Texas
- Western Electric
 Ortho-tronic Model J A M A 121 1283 (April 17) 1943
- Western Electric Model 63 J A M A 131 895 (July 13) 1946
- Western Electric Model 64 J A M A 134 605 (June 14) 1947
- Western Electric Models 65 &
 66 J A M A 137 534 (June 5) 1948
 Mfr Western Electric Com-
 pany Inc
 120 Broadway
 New York 5

Zenith Radionic Model A-2-A	J A M A	127 159	(Jan 20) 1945
Zenith Radionic Model A-3-A	J A M A	127 159	(Jan 20) 1945
Zenith Radionic Model B-3-A	J A M A	127. 158	(Jan 20) 1945
Zenith Model 75	J A M A	135 773	(Nov 22) 1947

Mfr Zenith Radio Corpora-
tion

6001 Dickens Avenue

Chicago

All the accepted hearing devices employ vacuum tubes

Abstracts from Current Literature

Ear

THE CIRCULATION OF THE LABYRINTHINE FLUIDS EXPERIMENTAL INVESTIGATION
IN RABBITS FRANZ ALTMANN and JULES G WALTNER, *Ann Otol, Rhin
& Laryng* 56 684 (Sept) 1947

The authors review the work which has been done on the physiology of the labyrinthine fluid. It is generally accepted that the greater part of the endolymph is formed in the stria vascularis of the cochlear duct. Other sources probably exist, although nothing definite is known about them. Resorption of the endolymph is thought by some to take place mainly in the endolymphatic sac, but destruction of this structure and the medial portion of the endolymphatic duct produced no histologic changes in the membranous labyrinth, so it is impossible that the endolymphic sac is the only point of resorption.

The origin and ultimate fate of the perilymph is not clear, either. Some think it is only cerebrospinal fluid which has entered the perilymphatic spaces via the cochlear aqueduct, others think it is derived from endolymph which has diffused through Reissner's membrane, still others think it originates in the blood vessels of the cochlea. Some maintain that it is derived partly from cerebrospinal fluid and partly from certain structures within the inner ear—either from the endolymph or from the blood within the modiolus.

In an attempt to clarify some of these points, the authors injected 0.5 to 1.0 cc of 1 to 166 per cent potassium ferrocyanide and ferric ammonium citrate into the cisterna cerebellomedullaris of rabbits, after withdrawing the same amount of cerebrospinal fluid. They describe their results and, with certain reservations, come to the following conclusions:

The perilymphatic fluid in rabbits is derived mainly from cerebrospinal fluid which reaches the perilymphatic spaces chiefly through the aqueductus cochleae and to some extent through the internal auditory meatus. In view of the fact that Reissner's membrane is so easily penetrated by solutions of iron salts, the possibility exists that some of the perilymph is derived from the endolymph. In the experimental animals, however, the iron salts penetrated from the perilymphatic into the endolymphatic space of the cochlea. If the pathway followed by the iron salts is indicative of the physiologic currents within the perilymph, it can be stated that the resorption of the perilymph within the cochlea takes place at a very rapid rate in the ligamentum spirale and the crista spiralis. No conclusions can be drawn concerning the fate of the perilymph in other parts of the labyrinth. The same evidence makes it probable that resorption of endolymph also occurs at the same places within the cochlea. This would explain the lack of dilatation of the endolymphatic system after obliteration of the endolymphatic sac. In view of the great difference in the structure between the aqueductus cochleae and the modiolus in rabbits and those in man, conclusions based on these experiments in rabbits are not necessarily valid for man.

M V MILLER, Philadelphia

THE REPORT OF A CASE OF CLOSURE OF A POSTAURICULAR MASTOID FISTULA
MAURICE M. PIERCE, *Laryngoscope* **57** 501 (July) 1947

Pierce describes a method of closure of a postauricular mastoid fistula which is easily performed and which gives a good cosmetic result. The mastoid cavity is revised and then filled with bone chips taken from the crest of the ilium. The skin, which has been undermined, is closed. Healing takes place without leaving a depression.

HITSCHLER, Philadelphia

THE PRACTICAL ANATOMICAL AND SURGICAL CONSIDERATIONS FOR EXPOSURE OF THE FACIAL NERVE
FRANK D. LATHROP, *Laryngoscope* **58** 743 (Aug.) 1948

Lathrop gives a detailed description of the surgical anatomy of the facial nerve and tells how to find it and how to avoid injuring it. He explains the methods of exposure of the facial nerve in the face, neck and temporal bone.

HITSCHLER, Philadelphia

COMMENTS ON THE RESULTS OF TREATMENT WITH THE NASAL RADIUM APPLICATOR
A. H. HILDING, *Laryngoscope* **58** 1103 (Oct.) 1948

Hilding presents a good review of nasopharyngeal irradiation, with results in a series of 50 cases. The cases are divided into groups according to the diagnosis, and the results obtained in each group noted, these results are particularly interesting.

HITSCHLER, Philadelphia

Pharynx

HEMANGIOMAS OF THE MOUTH
FREDERICK A. FIGI, *Ann Otol, Rhin & Laryng* **56** 853 (Dec.) 1947

Hemangiomas are often encountered about the face and neck and may extend into the oral cavity, but hemangiomas limited to the interior of the mouth are rare. These tumors are congenital or appear shortly after birth and in general are divided into capillary and cavernous types, both of which are subdivided. Capillary hemangiomas include the port-wine stain, or nevus flammeus, and the strawberry birthmark of the hemangioma simplex, the former may involve the oral mucosa, but the latter has not been seen by the author. Cavernous hemangiomas often occur in adults as small, varix-like masses at the vermilion border of the lips or in the oral mucosa and may be due to trauma. The congenital forms may be large and cause enlargement and distortion of the involved parts. Closely allied to the cavernous type are the plexiform or racemose hemangiomas, but these are less common and are probably cavernous hemangiomas with single or multiple arteriovenous fistulas. They are expansile, pulsating tumors, which may be diffuse and of considerable extent. They can be only partially obliterated by pressure and become tenser than simple cavernous angiomas when the patient strains or the part is dependent. A bruit is usually audible and a thrill frequently palpable. Because of arterial pressure they are firmer than the simple cavernous hemangiomas and tend to progress. Phleboliths are commonly found in cavernous hemangiomas in adults and vary from rather soft consistency to calcareous hardness and range in diameter from 2 to 3 mm. to more than 1 cm.

Since the vessels composing the strawberry type of capillary hemangioma are lined with the infantile form of endothelium, they respond well to irradiation. The author prefers this method to excision or the use of solid carbon dioxide and says that it produces a minimum of scarring. Port-wine stains are largely lined with a flattened, adult type of cell, and the cells give little or no response to irradiation.

If radiation is used, many of these later show malignant degeneration. Cosmetics are best used to hide the stain. Sometimes excision with skin grafting is used. A nevus flammeus of the lip associated with a cavernous hemangioma which is causing enlargement and deformity should be controlled by electrocoagulation and by the injection of a sclerosing solution before excision and skin grafting.

In general, irradiation is the treatment of choice for strawberry birthmarks and cavernous hemangiomas in infants and small children. In adults, cavernous lesions are more effectively treated with electrocoagulation and injections of boiling water or sclerosing agents. Well circumscribed hemangiomas often are best excised. Plexiform or racemose hemangiomas usually require ligation of the afferent vessels, in addition to the measures employed in treating cavernous hemangiomas.

MILLER, Philadelphia

EDEMA OF THE UVULA FOLLOWING DEMEROL-HYOSCINE ANALGESIA V R MOORMAN and I M BIRENBOIM, *Laryngoscope* **59** 66 (Jan) 1949

Edema of the uvula following scopolamine medication is rare but has been reported (9 cases, including this one). It is a problem primarily encountered on the obstetric service. (Many otolaryngologists use scopolamine for pretonsillectomy analgesia—W J H.) The edema includes the glottis and usually is so severe that tracheotomy is necessary for relief.

HITSCHLER, Philadelphia

POSTOPERATIVE TONSIL BLEEDING STUDIES OF THE ETIOLOGY, PREVENTION AND MANAGEMENT H GRANT PRESTON, *Laryngoscope* **59** 251 (March) 1949

Preston comprehensively discusses tonsillar bleeding, its prevention and control. The postoperative use of vitamin K greatly reduces the incidence of hemorrhage. Ascorbic acid may also be useful. On the other hand, the use of large amounts of acetylsalicylic acid or of gum containing this agent or undue operative trauma may increase the likelihood of this complication. Many other factors are discussed.

HITSCHLER, Philadelphia

Larynx

COMPRESSION OF THE TRACHEA BY AN ANOMALOUS INNOMINATE ARTERY AN OPERATION FOR ITS RELIEF ROBERT E GROSS and EDWARD B D NEUHAUSER, *Am J Dis Child* **75** 570 (April) 1948

Working in the departments of surgery and radiology at Harvard Medical School, Gross and Neuhauser have reported previously on surgery of the chest in children. Hitherto, anomalies of the aortic arch and associated vessels have been medical curiosities only, but now that the radiologist with contrast mediums can give an accurate diagnosis, some hope of surgical relief can be afforded in certain selected instances. A baby weighing 8 pounds (3,628.5 Gm) was born June 2, 1946, by forceps delivery. There were no noticeable defects, but regurgitation or vomiting was persistent for four months before an accurate diagnosis was made by roentgenogram. There was noisy wheezing dyspnea, relieved only by hyperextension of the head. Iodized oil injected into the trachea permitted photographing of the outline of pressure exerted on the trachea from left to right by an anomalous artery. The operation was undertaken October 17, with the patient under cyclopropane anesthesia, positive pressure being maintained in the lungs by means of a tight-fitting face mask. After operation, the technical details of which are described, the chest was closed and the lung reexpanded fully with subsequent improvement in respiration. The patient was discharged from the hospital on the eighth day!

[Comment With obstruction of the respiratory tract from whatever cause, infections are often fatal Therefore tracheal obstruction, especially, must be relieved if a plan of operative procedure can be laid out The operation described "was not particularly difficult" Explorations of the infant chest are "major" in importance, and demand "adequate facilities" in every detail]

VOORHEES, New York

Nose

PENICILLIN THERAPY IN CHRONIC SUPPURATIVE SINUSITIS A REPORT OF 22 CASES HAROLD BOYD, *Laryngoscope* **57** 460 (July) 1947

Boyd reviews the literature on the treatment of sinusitis with penicillin There is little doubt that penicillin aids in the treatment of the acute form and in conjunction with sinus surgery He presents the results of penicillin therapy in 22 cases of chronic sinusitis, in all of which some previous treatment other than with penicillin had been used Each patient was thoroughly studied before treatment was begun and checked thirty days after treatment was ended Roentgenograms and bacteriologic studies, including tests for sensitivity to penicillin, were made Local treatment, including surgical procedures when necessary, was performed Twenty-thousand units of penicillin was given hypodermically every fourth hour The results were good almost without exception

HITSCHLER, Philadelphia

VASOMOTOR RHINITIS ITS PHYSIOPATHOLOGIC MECHANISM, EFFECTS OF THE PROCAINE HYDROCHLORIDE INFILTRATION OF THE TEMPORAL ARTERIES O GODIN and W CLOETENS, *Acta oto-rhino-laryng belg* **1** 3, 1947

The authors classify the patients as of five types, according to the pathogenesis of the nasal syndrome

Allergic Type—Here the nasal blockage, sneezing and watering are due solely to extraneous substances—pollens, dusts, etc No permanent circulatory systemic disturbances are present in this group The antigen contained in the inhalant is neutralized by antibody, producing histamine, which brings about passive dilatation of capillaries and terminal arterioles and constriction of terminal veins The effect is that of stasis, edema by transudation and increased peripheral venous pressure The treatment of this type is (1) systemic—desensitization and administration of a double salt of calcium bromide-galactogluconate (calcibronat®) and antihistaminic agents (N,N-dimethyl-N'-phenyl-N'-benzylethylenediamine [antergan,® or 2339 R P] and N,N-dimethyl-N'-[p-methoxybenzyl]-N'-[α-pyridyl] ethylenediamine [neo-antergan,® or 2786 R P "Special"]], (2) local—a therapy combining the antihistamine action of 2-(N-phenyl-N-benzylaminomethyl) imidazoline (antistine®) with the constrictor effect of naphazoline hydrochloride (privine hydrochloride®) No procaine hydrochloride infiltration of the type described in the following section is indicated here

Circulatory Type—The nasal symptoms are protracted and are made worse by changes of posture, of external temperature and of barometric pressure Often no specific cause is found, and the allergy tests are not contributory This group comprises the largest number of patients In this group associated systemic circulatory disturbances are common—chilliness cold and cyanotic conditions of the extremities, frostbite The nasal mucosa is pale and boggy, frequently showing polypoid degeneration The authors find that in this group the peripheral arterial pressure is normal but the peripheral venous pressure is markedly low (they use Villaret's technic with Claude's water manometer, connected by a 40 cm rubber

tube filled with sodium citrate solution to a vein of a forearm) They suggest, as the physiopathologic mechanism in this group, a spastic constriction of terminal arterioles with resulting dilatation of capillaries and terminal venules The histamine does not produce this capillary effect, as it does in patients with hay fever of pure allergic type This circulatory mechanism is comparable to Raynaud's disease (second stage) The treatment comprises (1) administration of 1-(p-hydroxyphenyl)-2-methylaminoethanol tartrate (sympatol®), a peripheral vasodilator, which, used alone, gave the authors 9 cures, 4 improvements and 3 failures in 16 patients, (2) crossed endocrine therapy (estrogens in males and testosterone in females), which enhances the effect of the aforementioned drug, (3) procaine hydrochloride infiltration of the sympathetic nerve plexus of the temporal arteries It is performed by injecting 4 to 5 cc of a 1 per cent procaine hydrochloride solution without epinephrine hydrochloride into the subcutaneous tissue surrounding the temporal artery on both sides The immediate effect is marked shrinking of the turbinal mucosa, lasting from six hours to several days, repeated injections bring a lasting effect of several months At the same time, this procainization of the sympathetic nerve plexus suppresses the generalized arteriolar spasm and brings a return of normal systemic venous pressure

Endocrine Type—Menstrual disturbances are associated (amenorrhea, dysmenorrhea), allergy tests are not contributory, peripheral venous pressure is below normal The nasal symptoms, mostly intermittent, coincide often with the onset of an irregular menstrual cycle or with the onset of the menopause The pathogenesis appears to be in variations of the blood level of estrogen, causing arteriolar spasm and fall of pressure in terminal veins This type requires estrogenic treatment and benefits also from procaine hydrochloride infiltration of the sympathetic nerve plexus of the temporal arteries

Mixed Endocrine-Circulatory Type—Here the nasal symptoms are more permanent than in the previous group, they occur mostly after the menopause The pathogenesis is in peripheral arteriolar constriction, and the systemic signs are those of the two preceding groups combined The treatment consists in use of sympatol® and estrogens and temporal procaine hydrochloride infiltration

Constitutional Type—Allergic nasal symptoms appear early in childhood, other allergic manifestations, particularly bronchial asthma, are often associated The allergic background is inherited Endocrine and circulatory disturbances, such as cyanosis and coldness of the extremities, are common In this group the peripheral venous pressure was found increased in contrast to the previous types The pathologic mechanism here is apparently a loss of tonicity of the capillaries The nasal symptoms are induced as well by the extraneous allergens as by the circulatory factors (arteriolar spasm) The treatment of this type is mostly symptomatic, estrogens, calcibronat® and ephedrine are helpful, procaine hydrochloride infiltration gives inconstant improvements and influences the associated bronchial asthma more than the vasomotor rhinitis

HERSON, Chicago

Miscellaneous

DIPHTHERIA OF THE ESOPHAGUS A CASE INVOLVING THE STOMACH AND TONGUE
ARCHIBALD L HOYNE, Am J Dis Child 74 80 (July) 1947

A white girl, born on Jan 18, 1946, was admitted to the Municipal Contagious Disease Hospital, Chicago, on February 20 The diagnosis at examination was pharyngeal and tonsillar diphtheria, with profound toxemia and bronchopneumonia In spite of all treatment, the patient died five hours after admission There was

no history of exposure to diphtheria. While cultures from the child's nose and throat yielded diphtheria organisms, cultures obtained from both parents were sterile. Autopsy showed that a continuous, tough, grayish membrane extended from the base of the tongue down the entire length of the esophagus and protruded into the stomach like a flower. The inner surfaces of the larynx, trachea and bronchi were free from exudate.

The author comments on the relative rarity of diphtheria of the esophagus and of the stomach and states that such a diagnosis is not likely to be made during the life of the patient. However, a careful examination of the esophagus in cases of severe pharyngeal diphtheria might result in more frequent reports of this condition. How a 33 day old baby, breast fed exclusively, contracted diphtheria without known exposure or contact was not determined.

VOORHEES, New York

ONE STAGE PHARYNGEAL DIVERTICULECTOMY. T. A. SHALLOW and L. H. CLERF,
Surg., Gynec. & Obst. **86** 317 (March) 1948

Preference is expressed for a one stage surgical procedure with the simultaneous teamwork of surgeon and esophagoscopist. Preoperative preparation is directed toward correction of nutritional deficiencies and detection of concomitant disease. In the operative approach, the esophagoscope is employed for emptying the sac and for the maintenance of the normal anatomic position of the pharynx and upper part of the esophagus throughout the operation. Open drop ether anesthesia is used.

Introduction of the esophagoscope into the subdiverticular portion of the esophagus is facilitated by the use of an olive-tipped bougie passed over a previously swallowed string. At the conclusion of the operation, a feeding tube is inserted through the esophagoscope into the lower portion of the esophagus. After amputation of the sac, the stump is transplanted upward, beneath the inferior constrictor muscle. The muscular defect in the pharyngeal wall is corrected by approximating the upper margin of the cricopharyngeus to the lower margin of the inferior constrictor muscle. This suture line is anchored posteriorly to the prevertebral fascia, thus obliterating the retropharyngeal space and erecting a barrier against descending infection.

In the entire series of 186 cases, there were 5 deaths, a mortality rate of approximately 3 per cent. The authors thus conclude that the mortality for the one stage pharyngeal diverticulectomy is no greater than would be expected for any other major operation in patients of this age group.

FRIEDBERG, Chicago

Book Reviews

Oral Surgery By Kurt H. Thoma, D.D.M., Professor of Oral Surgery and Brackett Professor of Oral Pathology, Harvard University, Oral Surgeon and Chief of Dental Department, Massachusetts General Hospital. Two volumes. Price, \$30. Pp. 1,521, with 1,631 illustrations, 121 in color. St. Louis: The C. V. Mosby Company, 1948.

It will doubtless come as a surprise to many readers to find a work of over 1,500 pages dealing solely with the mouth, jaws and adjacent structures. (Most physicians could tell in a few words all they know about this subject unless they have read widely or have taken it up as a side line.) But here is a further surprise. The work is notable for its omissions, listed by the author. There is nothing here concerning harelip or cleft palate. These are treated in "Oral Pathology," a previous book written by Dr. Thoma. There is nothing about orthodontia, and "another purposeful omission is the topic of surgical prosthesis." What, then, is offered in this massive text? One can do little more than describe the general layout of the volumes.

The book is based on the assumption that the physician should know all that he can about the patient from a general medical standpoint. To quote Dr. Thoma: "To some, it may seem that supportive care has been overemphasized. I feel, however, that the general treatment is inseparable from the treatment of regional disease—the correction of deficiency diseases, the improvement of the general health by diet and rest, general medication to relieve pain, and the administration of drugs to prevent or eliminate infection and decrease the risk of operation, as well as postoperative physiotherapy to improve function." This is, indeed, a large order, but it is sound in plan, even if it may become difficult in practice. Overcoming difficulties is basic in any form of therapeutic procedure. This book was written for the undergraduate in medicine and dentistry and for the graduate student who is interested in dental and oral surgery.

As is fitting, chapter I deals with the principles of surgery, which, of course, are elementary in any such text. Surgical bacteriology, nutritional factors, asepsis and antisepsis, anesthesia and biologic research are discussed. Tracheotomy, procedures of plastic surgery and bone grafting are also described here, but these subjects might be classified to better advantage elsewhere in the book.

Dentoalveolar surgery includes replantation and transplantation of teeth, as well as their extraction. Exodontia, or tooth extraction, has long been a highly specialized field, but it had its origin at any rate in the hands of the old-time general practitioner of medicine.

Chapter III is concerned with treatment of traumatic diseases of the jaws and of fractures of the jaws, but with special reference to infections, such as osteomyelitis. An important phase is the management of delayed union and malunion. In general, fractures of the mandible belong in the field of dentistry, rather than in that of general surgery, since preservation of teeth or loss of them is strictly a dentist's responsibility.

Chapter V will interest the ear, nose and throat specialist, since it deals chiefly with the maxillary sinus. It has long been a matter for serious discussion whether maxillary sinusitis is primary, involving a tooth secondarily, or whether the disease is carried from an infected tooth into the antrum, certainly, either is

possible, and the question is chiefly one of academic interest. The matter of management is paramount. The ear, nose and throat specialist should be grateful for an acknowledgment that oroantral fistulas often follow tooth extraction, with enlargement of the socket by the dentist by use of the curet and the electrically driven burr. This operation is one of the worst in all surgery, since an otherwise normal antrum may be infected from the mouth. Thereafter, pus is drained inadequately from the antrum into the mouth, and no amount of irrigation and attempted "sterilization" can overcome this inadequacy of drainage. The opening is usually at the site of the second cuspid or the first molar. Cure is accomplished by way of a radical operation on the antrum followed by an effort to produce growth of new tissue to the fistulous opening. If and when the antrum is clean, any one of several procedures in plastic surgery may be performed to "close the hole." One may be grateful, too, for the statement that the Caldwell-Luc operation is preferred, "since the Denker operation frequently interferes with the innervation of the teeth." This is reason enough, but one might add that another reason for its preference is that it is not good surgical procedure to destroy a mass of normal bone—the anatomic pillar of the superior maxilla. Moreover, the Denker operation is unnecessary, since the Caldwell-Lac procedure gives such highly satisfactory results.

Volume II opens with a discussion of the mandibular joint. The joint is affected by the same diseases with which other joints are involved, especially with rheumatoid arthritis, arthritis of infectious origin and ankylosis. Certain aural disabilities are said to be due sometimes to lesions of the mandibular joint. Relaxed ligaments give rise to dislocations and to changes in the synovial fluid, of which there may be too much or too little, this being the diagnosis often made by the rhinologist. Operation on this joint is fraught with many pitfalls, which are mentioned by Dr. Thoma at sufficient length. The clinical varieties of infections of the face and neck following tooth extraction are interesting and significant and are adequately discussed in this volume. The presence of stone in the salivary ducts, dermoid cysts, cysts of the jaws, tumors of the jaws and conditions which involve the fifth and seventh nerves are the principal subjects set forth in this second volume. In chapter XII is discussed benign tumors of the mouth and jaw, while chapter XIII has to do with malignant tumors of these areas. The final chapter (XIV) is concerned with surgical treatment of deformities of the jaw which affect facial symmetry. Both operative and postoperative care are described clearly and completely.

It is probable that this work of Dr. Thoma will be standard for many years to come. So far as is known, there is no other book quite like it in the English language.

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CHORDA TYMPANI NERVE GRAFT

II Report of Follow-Up Observations One Year Postoperatively

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NEW YORK

THE SEARCH for the ideal surgical procedure in the treatment of otosclerosis which will restore the greatest initial and the greatest permanent improvement in hearing has inspired otologists the world over for the past seventy years. Shambaugh¹ reviewed the developments which culminated in the Lempert one stage fenestration operation. The physiologic validity of creating a persistent bony fenestra in an ear with a good reservoir of cochlear function is evidenced by the large number of patients whose remarkable improvement has been maintained from one to eight years.

Investigation of patients whose improvement regressed in a few weeks or months has shown that failure is due to closure of the fenestra (bony or fibrous) or to postoperative membranous labyrinthitis. Experimental studies with monkeys (Shambaugh¹) have supported these interpretations and revealed the pattern of bony regeneration and membranous labyrinthitis.

The different effects of labyrinthitis and fenestral closure may be illustrated by the postoperative sequelae. Initial recovery of hearing following fenestration is generally rather pronounced. It may last for one to three days, after which an abrupt reduction in hearing occurs. The lowered level of hearing, which may fall below the preoperative level, usually persists for six weeks or longer and is usually followed by improvement. Hearing reaches its maximum improvement at this stage. In many cases the improvement has been maintained for many months or years. In the large majority of cases if the restored level has been maintained for a year, it usually remains. After two years, the restored level is regarded as permanent. However, a significant number of patients have shown a gradual decline, starting six to ten months postoperatively, and most if not all of the initial improvement is eventually lost.

From the Otolaryngological Service of the Mount Sinai Hospital, New York.
Read at the Mount Sinai Hospital clinical conference, April 19, 1948.

¹ Shambaugh, G. E., Jr. The Fenestration Operation for Otosclerosis, J. A. M. A. **130** 999 (April 13) 1946.

Clinical and experimental studies have furnished clues as to the physiologic basis of these events. The initial postoperative reduction in hearing is due in large part to traumatic serous membranous labyrinthitis. This may occur during the operation or may be transmitted postoperatively from close contact with the necessarily traumatized tympanomeatal flap, which covers the new fenestra. The delayed reduction in hearing has a different origin. It is due to the bony or fibrotic closure of the new fenestra.

From this description it is apparent that the search for further improvement in fenestration operations can be attempted from two viewpoints: reduction in postoperative labyrinthitis and prevention of closure of the artificial fenestra. Hitherto, most attention has been given to the latter aspect. Lempert² has experimented with moving the location of the fenestra, burnishing the fenestral walls and using metal obturators and cartilaginous stopples. Shambaugh,³ using continuous irrigation, the dissecting microscope and other modifications of the procedure, has reduced the incidence of bony closure with loss of the improvement in hearing to 5 per cent of the patients followed for more than two years.

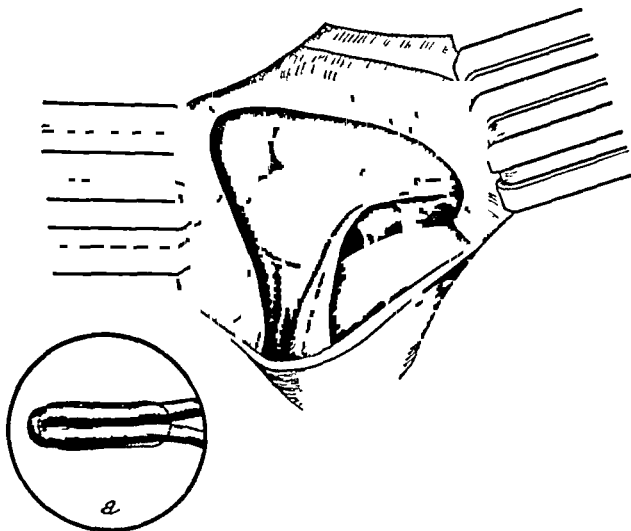
Much less attention has been given to the reduction of labyrinthitis. Lempert has given penicillin prophylactically to avert infectious inflammation. Shambaugh has reported earlier improvement in hearing—i. e., reduced inflammation of the membranous labyrinth—with the use of sea-sponge packing to prevent blood and serum from reaching the cochlea.

I consider that reduction of inflammation of the membranous labyrinth is of the greatest importance. Blood and other products of extralabyrinthine inflammation and trauma (to tympanomeatal flap and bone) extend to and involve the membranous labyrinth with depression of cochlear function. No matter how perfectly the fenestration operation is performed, if the membranous labyrinth becomes irreversibly and severely inflamed, poor hearing or total deafness may result, even though the fenestra remains wide open permanently. The membranous labyrinth and organ of Corti must be protected to the utmost because the present technic makes it necessary to cover the fenestra with a traumatized and inflamed tympanomeatal membrane. Careful and minimal handling of all the vital structures, especially the fenestra and the flap, is essential in order to reduce the unavoidable traumatic inflammation to a minimum.

² Lempert, J. Improvement in Hearing in Cases of Otosclerosis, *Arch Otolaryng* 28:42 (July) 1938, Fenestration Nov-Ovalis, *ibid* 34:890 (Nov) 1941.

³ Shambaugh, G. E., Jr., and Juers, A. L. Surgical Treatment of Otosclerosis. A Preliminary Report on an Improved Fenestration Technic, *Arch Otolaryng* 43:549 (June) 1946.

A search was made for a suitable protective covering to separate the membranous labyrinth from the traumatized flap. After considerable trial on the cadaver, a technic was evolved for using the chorda tympani nerve (which is exposed during the operation) as a pedicle graft to cover the membranous labyrinth and shield it from direct contact with the traumatized flap which serves as the tympanomeatal membrane. The first part of the operation is performed in the standard manner described by Lempert. The semicircular canals are isolated and an artificial fenestra is made in the most anterior portion of the horizontal semicircular canal, thus exposing the delicate membranous labyrinth. Before the fenestra is made, the chorda tympani nerve is pulled out of its bony canal from its proximal attachment to the facial nerve. As soon



Direct view of chorda tympani as it covers the artificial fenestra on the horizontal semicircular canal. The fenestra is shown in dotted outline in insert *a*. In several cases in which the chorda was not long enough, a single thickness also proved effective.

as the fenestra is completed, the chorda is folded in a loop and laid over the long axis of the fenestra. Sufficient slack is allowed at the attached end of the chorda tympani above so that it remains in place when the fenestra is covered by the flap (the figure). The chorda tympani nerve seems eminently suited for the role of protective barrier to the membranous labyrinth, since it successfully withstands exposures to all degrees of acute purulent otitis media. Details of the technic have been presented⁴. None of the patients subjected to this procedure has experienced loss in the sense of taste.

4 Rosen, S. Chorda Tympani Nerve Graft. Preliminary Report of a New Technique in Fenestration Surgery, *Arch Otolaryng* 47 428 (April) 1948.

The chorda tympani nerve covering was successful in the first case in which it was attempted. On the first visit after discharge from the hospital, the patient reported exceptional recovery of hearing. Instead of waiting the usual six weeks before attempting to obtain audiometer readings I started readings on the fourteenth postoperative day. These showed loss of only 25 decibels in the speech range—512, 1024 and 2048 double vibrations. Two days later the hearing was normal—5 decibels or better. Since then, more than a year has elapsed and more than fifty readings have been taken. Table 1 shows the progress in this case. The level shown on the sixteenth postoperative day has been continuously maintained except for a few weeks in April and May 1948.

TABLE 1—*Recovery of Hearing After Chorda Tympani Grafting*

F W, woman aged 23, single, with mild diabetes, progressive deafness in both ears noted for three to four years, no family history of deafness, operation performed Feb. 5, 1947, recovery uneventful

	Total Range of Frequencies					
	Speech Frequencies					
	128	256	512	1024	2048	4096
Preoperative						
Air conduction	60	60	45	45	45	40
Bone conduction	25	20	15	0	15	30
Postoperative*						
14 days	15	15	25	25	25	25
16 days	0	5	0	5	5	5
1 mo	5	0	0	0	0	5
2 mo	0	0	0	0	0	5
3.5 mo	5	5	5	5	5	5
7 mo	5	5	5	5	5	5
9 mo	5	5	5	5	5	5
10 mo	0	0	0	0	0	5
12 mo	5	5	5	5	5	5

* All postoperative values are for air conduction

when the patient had acute sinusitis and an acute infection of the middle ear.

Four additional patients have had a complete year of postoperative follow-up. The results in each case are summarized in table 2. Patients N R, P S and M B have maintained hearing levels of 10 decibels or better over the speech frequencies. Patient R T has had some regression from maximum improvement but still maintains a level of useful hearing of 25 decibels.

Results below and above the speech frequencies have been more variable. Patients F W and N R have retained their maximum improvement at all frequencies. P S and M B have not shown as much improvement at 4096 double vibrations as at the speech or lower frequencies. Losses in these peripheral frequencies have not had any noticeable effect on hearing. All 5 patients are greatly pleased with

TABLE 2—*Recovery of Hearing After Chorda Tympani Fenestration in Selected Cases*

Total Range of Frequencies						
Speech Frequencies						
	128	256	512	1024	2048	4096
N R, woman aged 37, with two children, progressive deafness for seventeen years, no family history of deafness, operation March 5, 1947, large clot developed six days postoperatively in tympanum and under the entire flap resolved after four weeks						
Preoperative						
Air conduction	50	55	55	60	55	
Bone conduction	5	5		10		
Postoperative						
3 mo	5	5	5	5	5	5
6 mo	5	5	5	5	5	5
9 mo	5	5	5	5	5	10
12 mo	5		5	5		5
P S, woman aged 40, progressive deafness for over ten years, no family history of deafness, operation March 13, 1947, recovery uneventful						
Speech Frequencies						
	128	256	512	1024	2048	4096
Preoperative						
Air conduction	50	55	55	55	55	60
Bone conduction	5	5	5	5	5	
Postoperative						
3 mo	10	5	5	10	5	55
6 mo	10	10	10	10	15	45
9 mo	10	10	5	10	10	40
12 mo	10	10	10	10	10	50
R T, woman aged 37, with two children, progressive deafness for over ten years, operation March 5, 1947, recovery uneventful, nervous patient, readings not always reliable						
Speech Frequencies						
	128	256	512	1024	2048	4096
Preoperative						
Air conduction	60	60	65	65	55	55
Bone conduction	5	5	5	20	25	25
Postoperative						
3 mo	15	15	15	15	5	10
6 mo	40	40	40	25	15	50
9 mo	35	35	30	30	15	45
12 mo	25	20	25	25	25	50
M B, man aged 36, progressive deafness for five years, brother similarly affected, operation April 29, 1947, flap torn close to fenestra during operation, recovery uneventful						
Speech Frequencies						
	128	256	512	1024	2048	4096
Preoperative						
Air conduction	55	60	65	50	40	50
Bone conduction	15	15	30	20	25	20
Postoperative						
3 mo	20	20	20	15	10	30
6 mo	5	5	10	10	0	25
9 mo	5	5	10	5	10	30
12 mo	10	10	10	10	10	35

their improvement, and each has had complete remission of the psychologic symptoms commonly associated with profound deafness

The main observations in this series may be briefly summarized as (1) earlier postoperative recovery of hearing and (2) achievement of significantly better average hearing levels than hitherto reported. Four of these 5 patients have had essentially normal hearing for a full year after the modified fenestration operation. Because of the small size of the series these conclusions must be regarded as tentative.

The chief importance of these observations is in counteracting the pessimistic impression which has been spreading in medical circles as to the small and transient benefits from fenestration operations. Available evidence suggests that patients with disabling otosclerosis should not be discouraged from seeking surgical relief when the bone conduction is good. Inasmuch as nonsurgical treatment is of little or no benefit, it is hoped that this technic will be given a wider trial in otologic clinics.

101 East Seventy-Third Street

THE HEARING AID IN MIXED DEAFNESS

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AND

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PHILADELPHIA

IN THE fitting of a hearing aid the conductive and the perceptive type of deafness offer less difficulty than the mixed type. To simplify matters, some audiologists have subdivided the patients with mixed deafness into conductive-perceptive and perceptive-conductive groups.

Most commonly in cases of mixed deafness the otoscopic picture is that of chronic adhesive otitis media. There is frequently a large perforation in the drum membrane with absence of the greater part of the malleus and incus. The inner wall of the middle ear is excessively thickened, and bands of adhesions run from one intratympanic structure to another. The accompanying illustration is the typical audiogram of mixed deafness. There is a profound hearing loss for the high tones, but bone conduction is better than air conduction for the lower frequencies.

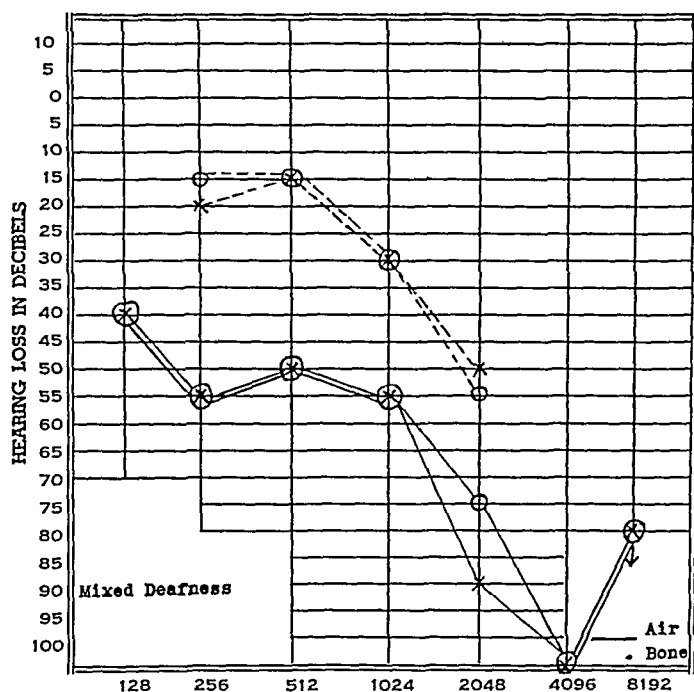
From a study of 12 patients with mixed deafness, in regard to the selection of a hearing aid, several generalities have been arrived at:

1. With some air receivers the patient's own voice becomes unbearable because of echoing and distorting sounds. Which hearing aid will produce these is unpredictable. Owing to the pathologic state of the ear, sound coming through the air receiver is transmitted by both air and bone conduction. Some frequencies are perceived by bone conduction and others by air conduction, with the occurrence of distortion. The echoing of the patient's voice must be attributed to a difference in phase relationship between the two routes through which the sound travels. That this is a peculiarity of some instruments acting on specific ears is proved by the fact that it is possible to select a hearing aid with an air receiver which presents no echoing effect to a patient with mixed deafness.

2. A bone receiver usually does not give good speech reception in a patient with mixed deafness.

From the Department of Otorhinology, Temple University School of Medicine

3 Mixed deafness is exceptionally prone to the recruitment phenomenon. A minimal amount of amplification frequently restores serviceable hearing.



Audiogram of patient R. N. aged 41. Circles represent the right ear, crosses, the left. Otoscopic examination revealed bilateral adhesive otitis media. The audiogram is typical of mixed deafness.

4 The frequency and the decibel loss patterns are less helpful in predicting a good fit for this than for other types of deafness.

1923 Spruce Street

1915 Spruce Street

STREPTOMYCIN TOXICITY OF THE EIGHTH NERVE

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WHY STREPTOMYCIN injures the eighth nerve is not known. Various clinical reactions and pathologic lesions have resulted in patients and animals from use of the drug. Brown and Hinshaw¹ observed vertigo and decreased labyrinthine function, as manifested by the caloric test in all of 23 patients with far advanced tuberculosis who were treated with streptomycin. Five patients had loss of hearing but they had tuberculous meningitis which may have been responsible. The authors warned that low-pitched constant tinnitus is a significant early symptom of approaching deafness. Mushett and Martland² and Stevenson and co-workers³ observed changes in dogs receiving large doses of streptomycin. The former noted vestibular dysfunction manifested by staggering, but observed no lesions in the central nervous system at autopsy. The latter noted degenerative changes in the vestibular nuclei. Stevenson also reported degeneration of the vestibular nuclei in 500 fatal cases of far advanced tuberculosis after treatment with streptomycin. Fowler and Seligman⁴ cited 81 cases of miscellaneous conditions in which streptomycin was given. The usual amount was 3 Gm a day for a relatively short time. Vertigo and (in several instances) loss of hearing developed. Farrington and co-workers⁵ gave

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Published with the permission of the Chief Medical Director, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or conclusions drawn by the author.

1 Brown, H A, and Hinshaw, H C. Toxic Reaction of Streptomycin on Eighth Nerve Apparatus, Proc Staff Meet, Mayo Clin **21** 347 (Sept 4) 1946

2 Mushett, C W, and Martland, H S. Pathologic Changes Resulting from Administration of Streptomycin, Arch Path **42** 619 (Dec) 1946

3 Stevenson, L D, Alvord, E C, Jr, and Cornell, J W. Degeneration and Necrosis in Eighth Cranial Nuclei Caused by Streptomycin. Proc Soc Exper Biol & Med **65** 86 (May) 1947

4 Fowler, E P, Jr, and Seligman, E. Otic Complications of Streptomycin Therapy. Preliminary Report, J A M A **133** 87 (Jan 11) 1947

5 Farrington, R F, Hull-Smith, H, Bunn, P A, and McDermott W. Streptomycin Toxicity. Reactions to Highly Purified Drug on Long-Continued Administration to Human Subjects, J A M A **134** 679 (June 21) 1947

3 Gm of streptomycin a day for one hundred and twenty days to 10 adults with active pulmonary or hematogenous tuberculosis. In addition to the vertiginous symptoms, deafness was observed in 2 cases.

Our experience confirms the earlier observations and illustrates the significance of the time when symptoms appear, as well as the severity, duration and ultimate outcome of these symptoms.

PRESENT INVESTIGATION

Type of Patients—The 21 patients in this series were admitted to the Veterans Administration Hospital, Waukesha, Wis., for treatment of moderately or far advanced pulmonary tuberculosis under the Veterans Administration protocol. All were white men from 21 to 58 years of age, the average age being 30 years.

Dosage—All patients received 2 Gm of streptomycin dihydrochloride daily (five doses at four hour intervals) for one hundred and twenty days, with 1 exception. That patient required desensitization twice, which prolonged treatment, but eventually he also received a total of 240 Gm.

Technic—Caloric tests were made by instilling 2 cc of ice water in the external auditory canal, with the patient in the recumbent position and with the head turned to the side. The water was allowed to remain until nystagmus developed. If none was noted in one and a half minutes, the canal was emptied and refilled with ice water. If nystagmus began in twenty to forty seconds and lasted ninety to one hundred and twenty seconds, function was considered normal. Hypofunction of the vestibular mechanism was classified according to the length of time between the instillation of ice water and the onset of nystagmus, as follows: *slight, forty to seventy seconds, moderate, seventy to ninety seconds, serious, over ninety seconds and requiring repeated instillations, severe, over one hundred and twenty seconds, with nystagmus minimal and usually present only on lateral gaze, no nystagmus*. All patients had good vestibular function before treatment. Caloric tests were given weekly during streptomycin therapy and at intervals ranging from two weeks, immediately after treatment, to three months, in the later follow-up.

Audiograms were obtained only for air conduction on a Maico D-5® audiometer. The testing was done in a room of ordinary size without soundproofing, but under quiet conditions. Hearing was tested before treatment, and then weekly until after administration of the full course of streptomycin.

Observations—Of the 21 patients who completed treatment, 6 left the hospital against medical advice or were transferred. One of the 6 died. Objective data on return of vestibular function are, therefore, limited to 15 patients.

Caloric Responses—In all cases caloric responses diminished during treatment, with the loss varying from moderate to total. Length of treatment, before reduction was noticed, varied from one to nine weeks, but was approximately four weeks in the majority of cases. The interval between initial loss and maximum reduction of response was one week in 90 per cent of cases and less than three weeks in 100 per cent. At the time of this report, the patients have been observed for eight to eleven months after completion of treatment, only 4 had normal responses. During treatment these 4 patients had moderate to severe

loss of vestibular function, recovery began four to five months after cessation of streptomycin treatment and was complete in seven to eleven months. Two other patients had slight improvement but were by no means normal, 1 had experienced complete loss of response. All the others continued to show serious or severe vestibular loss.

Vertigo—All patients experienced vertigo during their course of treatment. For convenience, we have graded the degree of vertigo as follows: 0, no vertigo, 1 plus, slight vertigo with transient reaction, usually noted only on sudden changes of position and causing no staggering, 2 plus, moderate vertigo, the patient being able to walk without support but staggering and needing help in darkness, 3 plus, serious vertigo, the patient walking fairly well but needing some support, 4 plus, severe vertigo, the patient walking with difficulty, even with support.

The appearance, progression and duration of vertigo followed the reduction in the caloric response almost exactly. The amount of vertigo varied from 1 to 4 plus but was 2 or 3 plus in 76 per cent of patients. Correlation of degree of vertigo to loss of caloric response, however, was not entirely consistent, although the majority of patients with the most strikingly diminished caloric response complained of serious or severe vertigo. If vertigo was severe soon after the administration of streptomycin was begun and the vestibular function was correspondingly reduced, the symptoms were persistent for a much longer period after cessation of treatment.

Maximum vertigo was usually experienced approximately at the time the minimum response to caloric stimulation was elicited. Thereafter, the majority of patients had a progressive but slow decrease in symptoms during the next several months, until most reached a stage at which some vertigo persisted, with little further improvement. At the time of writing, only 4 of 18 patients under observation have no vertigo, and they also have normal caloric reaction. None of the others have more than a 2 plus degree of vertigo. Practically all complain that dizziness is more noticeable in total darkness and that it is severest while they are in motion, as when walking or riding in a car. At such times the patient is unable to focus his eyes on objects or even to read large letter signs.

Because of the small number of subjects in this series, no accurate correlation can be made of age, degree of vertigo and amount of loss of response to the caloric test. However, all 4 men who were over 35 years of age suffered severe vestibular loss, with, on the average, slower and less complete return of function than did younger patients.

Compensation for vestibular loss was best evidenced by the patient's ability to walk steadily even when the caloric tests showed greatly diminished function. Compensation was rapidest and most advanced in patients who were allowed the most time out of bed.

Romberg Sign—Romberg tests, both by the ordinary method and with the patient standing in the toe to heel position, were done in all cases before vertigo appeared. All tests performed by the first method gave negative results. Repeat tests made at the height of vertigo gave positive reaction in 8 patients (38 per cent) when the ordinary method was used and in 20 patients (96 per cent) in the toe and heel method. Of the 5 patients with positive responses to the ordinary tests who are still under observation at the time of this report, 3 still have positive reactions, of 13 patients giving a positive response to the second type, 9 still give positive responses.

Hearing—Thirteen of the 21 patients had some hearing loss before treatment started but had no trouble in hearing normal conversation. In none was loss of hearing observed during or after streptomycin therapy.

Tinnitus—During treatment 17 patients (80 per cent) had intermittent, high-pitched tinnitus, the frequency of attacks ranging from occasional episodes to three or four daily. At present, all tinnitus is entirely gone or considerably diminished and is in no case incapacitating.

Miscellaneous Signs—Eosinophilia with values of 6 to 39 per cent was noted in all cases during treatment. No correlation, however, could be found between the degree of eosinophilia and the degree of vertigo or variation in responses to the caloric test. Levels now range from 8 to 1 per cent.

Four minor patients (19 per cent) experienced transient nausea and vomiting during treatment. This symptom also had no relation to severity of vertigo or the time of onset and ceased when 50 mg of diphenhydramine hydrochloride (benadryl hydrochloride®) was given five times a day.

A "measles-like" rash occurred in 8 cases (38 per cent), necessitating discontinuance of treatment and desensitization in 2 cases. The other outbreaks were controlled with diphenhydramine hydrochloride.

SUMMARY

While receiving treatment with 2 Gm of streptomycin dihydrochloride daily for one hundred and twenty days, 21 men with tuberculosis were carefully examined at frequent intervals to determine effects on the eighth nerve. Results were observed up to eleven months after cessation of treatment.

All patients experienced vestibular dysfunction of varying degree but none showed loss of hearing.

Although at the time of this report only 4 of the subjects have normal responses to caloric tests and are completely free of vertigo the others are not incapacitated.

The older patients appeared to tolerate streptomycin less well than did the younger men.

A NEW TREATMENT OF ACUTE AERO-OTITIS MEDIA

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A PROBLEM of growing importance in aviation medicine is one concerned with the treatment of acute aero-otitis media. The increasing volume of passenger traffic has resulted in a higher incidence of this condition. The precautions taken by military aviation personnel are not observed in commercial aviation. The risk of flying with infections of the upper respiratory tract is not realized by the average civilian passenger. In the seasoned flight passenger the press of business often occasions a disregard of this risk. This combination of factors is producing the higher incidence of acute aero-otitis media in commercial aviation.

Acute aero-otitis media was frequently observed in military flying personnel during World War II. It was one of the most common causes of discomfort among flying personnel. Aero-otitis media is an acute or chronic traumatic inflammation of the tympanum caused by a difference of pressure between the air in the middle ear and that of the surrounding atmosphere. The symptoms of aero-otitis media depend on the duration, the frequency and the severity of the barotrauma sustained. The symptoms vary from dull discomfort to severe pain of the ear and from stuffiness of the ear to marked deafness accompanied with tinnitus and occasional vertigo.

Since acute aero-otitis media is a physiopathologic entity resulting from differences of atmospheric pressure encountered in descent the severity of the condition is directly related to the rapidity of descent. For these reasons the United States Department of Commerce has set an allowable rate of descent for commercial airlines. Occasionally unusual conditions, such as weather require that these rates of descent be exceeded to insure the safety of the flight. Under these circumstances the incidence of acute aero-otitis media increases. However, the increased incidence is due chiefly to those who engage in aerial flights when afflicted with disease of the upper respiratory tract. Even strict adherence to the rate of descent cannot always prevent the development of acute aero-otitis media under these conditions.

* Formerly, Flight Surgeon and Instructor in Otolaryngology Army Air Forces School of Aviation Medicine Randolph Field, Texas

The barometric and physiologic conditions which produce acute aero-otitis media during descent in flight are illustrated in figure 1

It is noted that when one is descending from an altitude of 5,000 feet (1.5 kilometers), where the atmospheric pressure is 632.4 mm of mercury, to 1,000 feet (305 meters), where the atmospheric pressure is 733 mm of mercury, a pressure difference of plus 100.6 mm of mercury develops in the soft tissues and blood vessels of the middle ear. This positive cellular pressure is neutralized by transudation and exudation of tissue fluid.

Armstrong,¹ who originally described aero-otitis media as a clinical entity, pointed out that the condition results when there is inadequate

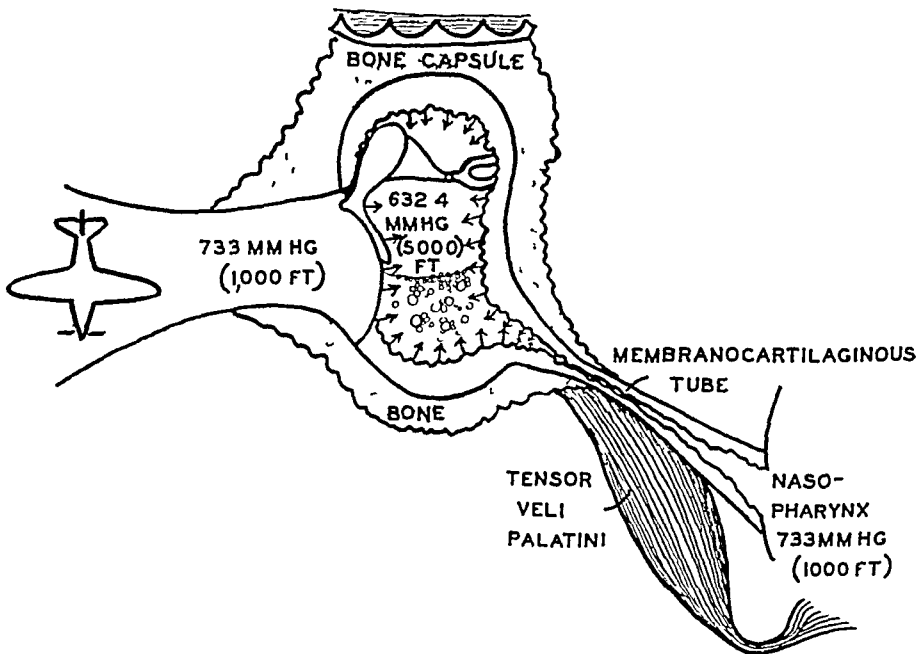


Fig 1—Barometric and physiologic conditions producing acute aero-otitis media

ventilation of the middle ear cavity during ascent or descent in flight. Inadequate ventilation of the middle ear may be due to any one of a number of conditions of the upper respiratory tract which produce inability to open the eustachian tube voluntarily. Inability to ventilate the middle ear voluntarily is much more prevalent than is generally recognized. Some of the more frequent causes of stenosis of the eustachian tube are acute and chronic infections of the upper respiratory tract, nasal obstructions, sinusitis, tonsillitis, tumors and growths of the nose and nasopharynx, paralysis of the soft palate or of the superior

1 Armstrong, H. G. Principles and Practice of Aviation Medicine, Baltimore, Williams & Wilkins Company, 1939, p. 207

pharyngeal muscles, enlargement of the pharyngeal or tubal tonsil, inflammatory conditions of the eustachian tube following adenectomy and malposition of the jaws

The diagnosis of acute aero-otitis media is readily suggested when a history of recent flight with pain occurring in the ear on descent is elicited. The clinical picture results from a type of trauma which is essentially like that of applying a suction cup to soft tissue. Consequently, the effect on the mucous membrane of the middle ear is one of a partial vacuum, resulting in vascular engorgement and eventual transudation and exudation of serosanguinous fluid. When sufficient

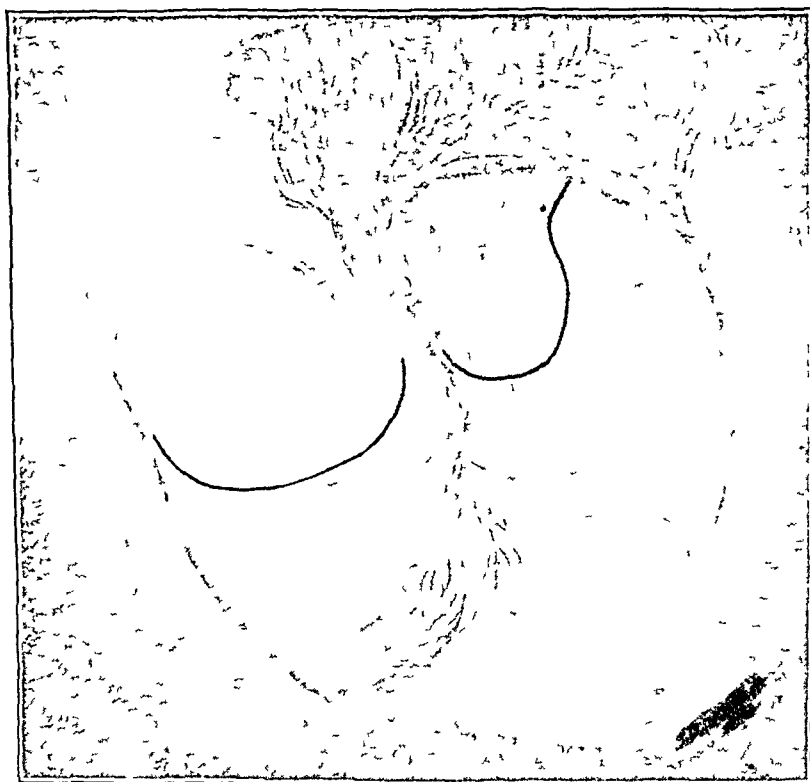


Fig 2—Acute aero-otitis media

fluid accumulates within the tympanic cavity the pressure difference becomes partially neutralized and the cupping effect is diminished. As a result, the tension on the collapsed eustachian tube is slightly relieved, and minute amounts of air enter the middle ear by autoinflation or during the act of swallowing. Hence, bubbles of air are usually observed within the fluid of the tympanum on otoscopic examination. These are not infrequently mistaken for blebs between the layers of the drum head (fig 2).

The objective signs of acute aero-otitis media depend on the degree of barotrauma sustained. Hemorrhage and rupture of the tympanic

membrane are rarely observed in commercial aviation. The average case of acute aero-otitis media incidental to commercial flight is characterized by moderate retraction of the drum head, pinkish discoloration of the tympanic membrane, decreased brilliance of the light reflex, increased prominence of the short process of the malleus, foreshortening of the handle of the malleus and the presence of straw-colored fluid in the middle ear cavity. Throughout the fluid, which is easily seen through the semitransparent tympanic membrane, are observed numerous air bubbles. The fluid line and air bubbles alter their position on movement of the head.

Resolution of acute aero-otitis media is initiated when the pressure difference between the middle ear and the outside atmosphere is neutralized. The length of the convalescent period depends directly on the rapidity of absorption and the drainage of the fluid entrapped within the tympanic cavity. Theoretically, the negative pressure of the middle ear should be mitigated by relieving the obstruction of the eustachian tube in order to permit drainage and absorption of the fluid entrapped within the tympanum. However, the fluid that early collects within the cavity of the middle ear effects a neutralization of the pressure differentials and precludes the possibility that relief may be obtained through treatment of the eustachian tube alone. Hence, the process of resolution is chiefly dependent on early absorption or removal of the fluid. Under the usual palliative and conservative treatment of acute aero-otitis media, absorption of the tympanic fluid occurs within a period varying from seven to twenty-one days, depending on the amount of fluid present. During this period the resumption of flying is not recommended. The average time of grounding of air crew personnel with this condition during the recent war was about twelve days. While the prognosis of acute aero-otitis media is extremely good under conservative treatment, there is much to be desired in shortening the period of convalescence. Under conservative care, therapeutic attention is directed to contributory causes as well as to the immediate cause in order to prevent recurrences. Local treatment of nose and throat in the form of application of vasoconstrictors and astringents and in combating the effects of infections of the upper respiratory tract. The Proetz displacement procedure, the use of analgesics and the application of heat to the ear and the nose are utilized to hasten convalescence. Autoinflation by the Valsalva method, politzerization and catheterization are employed to facilitate the draining of the serosanguinous fluid from the middle ear. Conservatism is based on the supposition that the serosanguinous exudate in the tympanum is sterile and that any attempted instrumentation may implant infectious organisms into a perfect culture medium. For this reason, myringotomy has not been used. While myringotomy permits instant

drainage of the fluid, the procedure is a rather drastic method which is not devoid of complications, particularly secondary infection

In view of the limitations of the aforementioned therapeutic procedures experimental aspirations of the tympanum were performed. It was found that when the secretion was removed from the middle ear by tympanotomy-aspiration the relief of the aural discomfort due to its accumulation was almost instantaneous. Furthermore the period of convalescence was shortened to an average of four days

A 1 cc tuberculin syringe with a no 22 spinal 3 inch (7.5 cm) (Quincke point) needle is used to aspirate the fluid (fig 3). The aspiration is made with the aid of a magnifying otoscope. Magnification aids in accurately locating the site of aspiration in the lower half of the tympanic membrane.

The most suitable point at which to transfix the drum head is just below and slightly posterior to the umbo (fig 4).

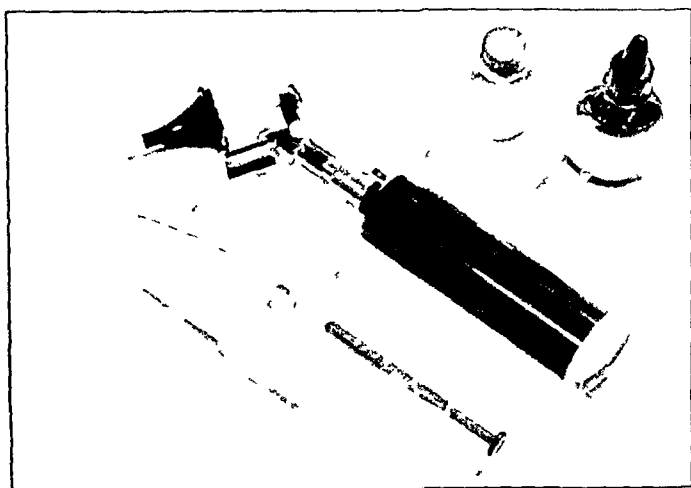


Fig 3—Instruments for the aspiration technic

Since the hypotympanum extends slightly below the level of the lower margin of the drum head, it is important that the needle point be placed as low as possible to aspirate effectively the fluid contents of the epitympanum, tympanum and hypotympanum at the same time. The average amount of fluid withdrawn is about 4 minims (0.25 cc). Prior to the aspiration of the fluid the tympanic membrane is anesthetized with an aniline oil-cocaine solution (chemically pure aniline oil 90 parts, cocaine hydrochloride 10 parts) topically applied. Anesthesia of the tympanic membrane should be obtained only by the topical application of this solution. The placing of viscous anesthetic agents and free anesthetic solution in the external canal is not recommended. A small cotton ear tampon, the point of which has been saturated in the aniline oil-cocaine solution, is placed against the lower half of the tympanic membrane and is allowed to remain in place for ten minutes. Following the removal of the cotton tampon, the drum head is wiped clean with a cotton applicator which has been saturated with the anesthetic solution. Thorough cleansing of the external canal and the proper application of the anesthetic solution are necessary to prevent secondary infection of the tympanum. Since in acute aero-otitis media the transverse dimensions of the middle ear cavity

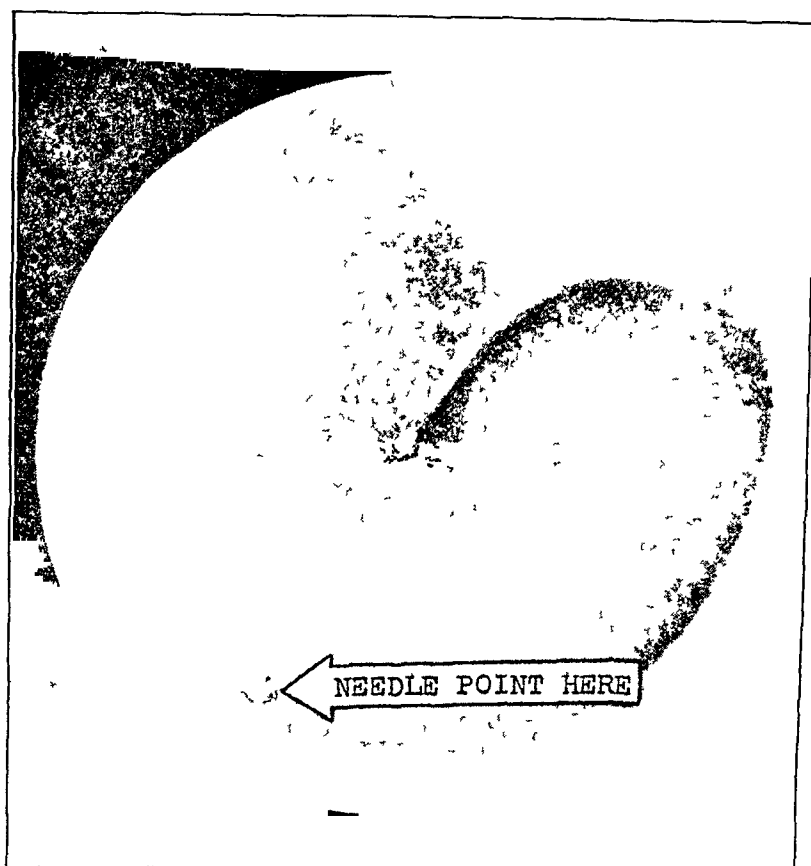


Fig 4—Site of aspiration

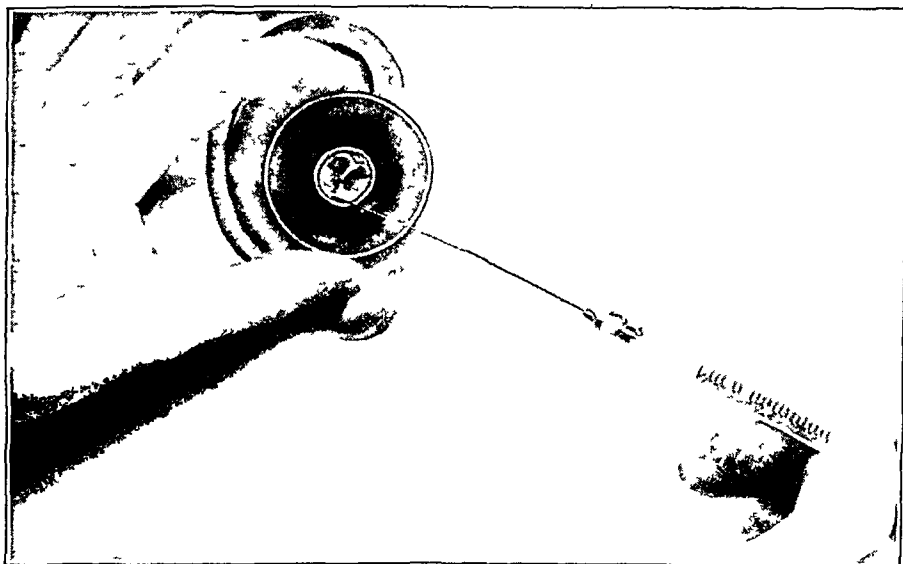


Fig 5—Aspiration of the fluid contents of the tympanum

are reduced by the retraction of the tympanic membrane, it is imperative that the needle point be held firmly in place during the aspiration in order completely to remove the fluid contents of the cavity. To accomplish this, the operator holds the syringe and needle in place while an assistant withdraws the plunger of the syringe (fig 5).

Immediately after the aspiration of the secretions the appearance of the tympanic membrane is greatly improved. The fluid contents of the middle ear have much to do with the discoloration of the tympanic membrane originally observed in acute aero-otitis media. On withdrawal of the needle a small pinpoint perforation can be seen in the drum head with the aid of a magnifying otoscope. This microscopic perforation heals within several days without any evidence of trauma to the tympanic membrane. Further treatment of the ear is not necessary after aspiration of the intratympanic fluid. Treatment of the nasopharynx should be continued until recovery occurs.

Aspiration Treatment of Acute Aero-otitis Media

Patient	Symptoms (occurred on descent)	Objective Findings	Duration (before seek- ing aid)	Aspira- tion	Results	Normal Ear Sensation
1 G A	Pain and ful- ness (L)	Fluid and air bubbles (L)	3 days	1	Immediate relief	4 days
2 P B	Severe pain and fullness (R)	Fluid and air bubbles (R)	1 day	1	Immediate relief	2 days
3 R M	Fulness and roaring tinni- tus (L)	Fluid and air bubbles (L)	4 days	1	Immediate relief	2 days
4 L W	Pain and "stopped up" sensation (R)	Fluid and air bubbles (R)	2 days	1	Immediate relief	2 days
5 L B	Deafness (R)	Fluid and air bubbles (R)	5 days	1	Immediate relief	4 days
6 P W	Pain and ful- ness (R)	Fluid and air bubbles (R)	3 days	2	Immediate relief	6 days
7 E O	Deafness (L)	Fluid and air bubbles (L)	7 days	2	Immediate relief	8 days

Since this method of aspirating fluid from the tympanum permits the withdrawal of uncontaminated secretions of the middle ear, it affords the only means by which the true bacteriologic state of these tympanic secretions can be determined. It has been generally accepted that in acute aero-otitis media the tympanic fluid is sterile. Bacteriologic studies of aspirated fluids have been done on blood agar and thioglycolate mediums and these have proved to be sterile.

The table shows the results obtained with aspiration therapy in 7 patients with acute aero-otitis media. All of the subjects reported that they had experienced aural pain and subsequent difficulty of hearing during descent in flight while in commercial aircraft.

After grounding, the constant feeling of fulness in the ear finally caused the patients to seek medical attention, but not until the disturbance of the ear had persisted for several days without spontaneous improvement. Their delay was probably due to the fact that pain was experienced only during descent and was not continuous thereafter.

The decision to recommend resumption of flying after the subjective symptoms of acute aero-otitis media have been relieved by aspiration of the tympanum is based on the necessity of flight and the severity of the contributing nasopharyngeal inflammation or mechanical obstruction. The safety valve effect of the microscopic perforation of the tympanic membrane permits continued flying activity of military personnel. This factor is of considerable importance in warfare when the tactical situation requires uninterrupted aerial activity.

The early aspiration of secretions shortens the convalescent period by equalizing differences of extratympanic and intratympanic pressure producing aeration of the middle ear cavity, reducing tympanic edema and minimizing complications involving the internal ear. While immediate relief of aural discomfort and deafness follows aspiration the sensation of a normal ear does not become apparent until several days later when the intratympanic edema has subsided. The aspiration of the straw-colored transudates, serosanguinous secretions and hemorrhagic exudates is an important preventative measure as well as a therapeutic one. The early removal of these secretions prevents their being organized into fibrous and adhesive processes which interfere with the functioning of the tympanic mechanism and eventually lead to impairment of hearing. Kos² demonstrated that deafness is a noticeable part of the picture of aero-otitis until resolution of this condition takes place. He stated that repeated attacks result in progressive interference with the conduction function. Lederer³ also stated that sterile fluid in an untreated ear gives rise to chronic forms of middle ear disease and that if the afflicted person is subjected to recurrences, the hearing will suffer sometime during life. It is in this condition that aspiration of the tympanum serves as a preventative measure as well as a therapeutic one. In many persons who have had repeated attacks of acute aero-otitis media an adhesive form of chronic otitis media develops with subsequent deficiency of hearing. This condition is greatly improved by tympanic injection therapy. It has been shown that the deficiencies of hearing particularly benefited by the intratympanic injection of ethylmorphine hydrochloride are those which arise in cases of chronic nonsuppurative inflammation of the middle ear.⁴

The accumulation of nonpurulent middle ear secretions is not peculiar to acute aero-otitis media alone. It is frequently observed in

2 Kos, C. M. Otolaryngological Problems in Aviation Medicine, Texas State J. Med. **38** 281, 1942.

3 Lederer, F. L. Diseases of the Ear, Nose and Throat, Philadelphia, F. A. Davis Company, 1938 p. 121.

4 Trowbridge, B. C. Injection of the Tympanum for Chronic Conductive Deafness and Associated Tinnitus Aurium. A Preliminary Report on the Use of Ethylmorphine Hydrochloride, Arch. Otolaryng. **39** 523 (June) 1944.

acute catarrhal otitis media, subacute catarrhal otitis media, secretory catarrh and serous otitis media. In these hypovirulent forms of middle ear inflammation the accumulation of intratympanic secretions is the result of a mechanical disturbance of the eustachian tube. The eustachian tube closes and the closure is followed by absorption of oxygen in the middle ear, resulting in negative pressure within the tympanum similar in nature to that developed in acute aero-otitis media. The vacuum produced often causes transudation of fluids from the lining mucosa of the middle ear. Factors which cause closure of the eustachian tube or interfere with its functioning are adenoidal growths, recurring nasopharyngitis, enlargement of tonsils, allergic rhinitis, acute rhinitis, acute eustachian salpingitis and nasopharyngeal irritation from swimming. Serous otitis media is not uncommonly observed following prolonged ether anesthesia. The treatment of the condition per se is by aspiration. If a residual impairment of hearing persists after one month the tympanum should be treated by injection of a 5 per cent solution of ethylmorphine hydrochloride.¹

CONCLUSIONS

1 The aspiration of the tympanum described is the most effective method of relieving the symptoms of acute aero-otitis media and shortening the period of convalescence.

2 The safety valve effect of the pinpoint perforation of the tympanic membrane permits resumption of flying if circumstances require this.

3 Aspiration of the straw-colored transudates, serosanguinous secretions and hemorrhagic exudates of the tympanum prevents their being organized into adhesive processes which result in permanent impairment of hearing.

4 Aspiration removal of nonpurulent tympanic secretions is the most effective therapeutic measure for obtaining prompt recovery from acute catarrhal otitis media, subacute catarrhal otitis media, secretory catarrh and serous otitis media and preventing the hearing deficiencies secondary to these conditions.

194 Plaza Time Building

CONTACT ULCERS AND LARYNGEAL TUBERCULOSIS

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THE CONCEPT of contact ulcers of the larynx was first advanced by Chevalier Jackson¹ in 1928, but since then the literature on this lesion has been rather scanty. As early as 1926, however (and also in 1937) Blegvad² called attention to laryngeal tuberculosis that manifests itself in swelling and redness of the mucous membrane of the vocal processes. In some cases he found ulcerations here. In addition, two case reports on nontuberculous contact ulcerations were published by Videbech³ and Hagerup⁴. In 1942 Blegvad⁵ discussed the possibility of tuberculosis as the cause of contact ulcers. He arrived at the conclusion that when one is faced by these ulcerations one should always think of the possibility that pulmonary tuberculosis is present, in contrast to what had been assumed previously. At the same time, Blegvad advanced the hypothesis that some of these ulcerations might be instances of pachyderma laryngis localized to the vocal processes alone, without involving the interarytenoid region.

Even though few autopsies with histologic examination of contact ulcers have been reported so far, numerous biopsy reports on such ulcerations have been published. Our experience has shown, however, that even when the entire suspected area is examined histologically at autopsy, it is often necessary to make serial sections in order to demonstrate any tuberculous changes. We believe, therefore, that a negative

From the Ear, Nose and Throat Clinic of the Øresund Hospital (Chief Physician, N. R. Blegvad, M D) and the Pathological Institute of the Kommune Hospital (Chief Pathologist, Svend Petri, M D).

1 Jackson, C. Contact Ulcer of the Larynx, *Ann Otol, Rhin & Laryng* **37** 227, 1928.

2 (a) Blegvad, N. R. Diagnostic du debut de la tuberculose du larynx, *Acta oto-laryng* **10** 508, 1927, (b) Discussion on the Problem of Early Laryngeal Tuberculosis, *Proc Roy Soc Med* **30** 221, 1937.

3 Videbech, H. Jackson's laryngeale kontaktsaar, *Dansk m selsk Forhandl*, 1938, p. 144.

4 Hagerup, G. Contact Ulcer, *Ugesk f læger* **100** 1117, 1938.

5 Blegvad, N. R. Contact Ulcer of the Larynx, *Nord med* **23** 1347, 1943.

result with regard to specific changes in the usually small pieces of tissue removed on biopsy is to be accepted only with reservation

We have therefore gathered material on patients with contact ulcers observed in the Øresund Hospital within the period from the middle of 1941 to the middle of 1946, because, among other reasons, a considerable number of autopsies have been performed on such patients. The Øresund Hospital is the municipal tuberculosis hospital of Copenhagen, in which patients with the more advanced stage of the disease are treated, while those with a milder form are treated in sanatoriums in the vicinity of Copenhagen. (The Øresund Hospital also has a department of pulmonary surgery, in which patients with nontuberculous pulmonary lesions are also treated.)

During this five year period 19 patients altogether presented laryngeal diseases which, according to Chevalier Jackson,¹ should be designated as contact ulcers. Of these 19 patients, 17 had severe pulmonary tuberculosis and 2 had nontuberculous lesions of the lung. The examinations of the posterior and lateral walls of the larynx mentioned in the case records were performed with ter Kuiles mirrors, the routine examination was given to all patients who were not too exhausted to take them and in whom a lesion in the interarytenoid region or on the vocal processes was either suspected or known to be present. Direct laryngoscopy was not performed on the tuberculous patients, partly because we believe that equally good information may be obtained with our method, but especially because we believe that direct laryngoscopy may aggravate laryngeal tuberculosis already present.

It may be wondered why only one vocal process was examined microscopically, even when autopsy revealed a bilateral disease. The reason for this is that prior to the present report no particular interest was taken in these ulcerations and hence the histologic examination in support of the macroscopic findings was limited to one side, whether the lesion was unilateral or bilateral.

REPORT OF CASES

The following case records are given merely as brief abstracts, only the microscopic observations being reported in detail. The Wassermann reactions were negative in all the cases.

CASE 1—A man aged 38, a bookbinder, died on Oct. 25, 1942, of bilateral pulmonary tuberculosis.

Examination of Larynx—On Jan. 11, 1940 no abnormality was found. On April 15, both vocal processes were slightly red and irregularly swollen. On June 10, there was an unquestionable ulceration of both vocal processes, besides redness and swelling of the right vocal cord. On Oct. 1, 1942, a slight redness of the entire mucous membrane was noted, especially of the vocal cords. On the left vocal process, a sharp-edged depression was seen on the right pale granulations.

Autopsy—On the right vocal process, a deep ulcer was seen, extending out on the vocal cord and measuring about 1 cm in length and 2 to 3 mm in width. A similar ulcer, but only half as large, was seen on the left vocal process.

Microscopic Examination—Sections from the right vocal process showed a large ulceration with undermined edges, an accumulation of inflammatory cells, besides epithelioid cells and giant cells in the marginal areas. In several places the inflammatory changes extended to the hyaline cartilage, which showed beginning sequestration.

The histologic diagnosis was tuberculosis of the right vocal process, with large ulceration.

CASE 2—A man aged 41, a musician, died on May 2, 1943 of bilateral pulmonary tuberculosis with cavitation.

Examinations of Larynx—On the patient's first admission, one year before, both vocal processes had shown a transitory redness, on the last admission the patient was moribund and laryngoscopy was not performed.

Autopsy—On each vocal process there was an ulceration nearly the size of a hempseed.

Microscopic Examination—Sections from the right vocal process showed a surface partially lined with stratified squamous epithelium normally differentiated of medium thickness and without cornification. There were several small ulcerations, some of them slightly undermined, in the connective tissue stroma. In areas corresponding to the ulcerations, were seen round cell infiltration and granulation tissue formation, with some epithelioid cells and a single giant cell of the Langhans type. The inflammatory processes appeared to make the preserved surface epithelium bulge a little, in one place they extended down to a fairly large piece of hyaline cartilage that showed beginning destruction.

The histologic diagnosis was tuberculosis of the right vocal process with small ulcerations.

CASE 3—A woman aged 23, a housewife, died on Aug. 19, 1943 of bilateral pulmonary tuberculosis.

Examination of the Larynx—On Feb. 3, 1942 examination showed extensive infiltration of the interarytenoid region. Biopsy indicated tuberculosis with ulcerations.

On her last admission, the patient was in such bad condition from tuberculous meningitis that no real examination of the larynx could be made.

Autopsy—In the interarytenoid region, and especially on the vocal processes the mucous membrane was slightly nodular, without macroscopic ulceration.

Microscopic Examination—In sections from the left vocal process the mucous membrane showed several small and larger partially confluent heaps of epithelioid cells together with many Langhans giant cells, a few areas of necrosis and, in addition, a rather pronounced lymphocyte infiltration. The nodular bulging of the surface was due to the inflammatory processes, and in a rather large area the epithelial lining was completely absent. There the specific changes formed the surface of the tissue, which, in this area too, was slightly convex, without any undermining. The hyaline cartilage was not affected by the ulceration but in some places the proliferation of epithelioid cells extended down to the perichondrium which there became detached, (fig. 1).

The histologic diagnosis was pronounced tuberculosis of the left vocal process with moderate superficial ulceration.



Fig 1 (case 3) —*A*, hypertrophic tuberculosis of the vocal process with superficial, not undermined, ulceration, $\times 35$ *B*, lively proliferation of epithelioid cells, with many giant cells, only slight necrosis, $\times 100$

CASE 4—A man aged 36, a stoker, died on Dec 30, 1943, of bilateral pulmonary tuberculosis with cavitation

Examination of Larynx—On December 17, examination showed irregular swelling of the mucous membrane of both vocal processes and red, thickened vocal cords

Autopsy—Both vocal processes showed a somewhat plateau-like, elevated and ulcerated area the size of a large hempseed Both vocal cords were swollen, and the right was possibly ulcerated

Microscopic Examination—In sections from the right vocal process, the surface was seen to be lined with stratified, normally differentiated, noncornifying squamous epithelium, which ranged from thin to moderately thick In one area the epithelium had disappeared, there the surface was slightly depressed but not undermined, consisting of somewhat old, partly necrotic granulation tissue Corresponding to this area, the stroma was strongly infiltrated with round cells, but no epithelioid cells or giant cells were seen Another area showed a large accumulation of epithelioid cells with central necrosis Owing to the sectioning of the specimen, it was uncertain whether there was any ulceration in this area In addition, the specimen showed numerous normal glands with normal or slightly cystic excretory ducts and also a piece of hyaline cartilage that stained poorly but showed no definite pathologic changes

The histologic diagnosis was tuberculosis of the right vocal process with slight ulceration

CASE 5—A mechanic, aged 58, died on Feb 23, 1944 of bilateral pulmonary tuberculosis with cavitation

Examination of Larynx—On Oct 1, 1942 the mucous membrane of both vocal processes was rather intensely red and somewhat irregularly swollen, especially the left On Dec 6, 1943, there was an irregular, probably ulcerated, area on each vocal process On Dec 27, 1943, granulations were seen on the vocal processes as well as in the interarytenoid region

Autopsy—The right vocal process was the site of a deep ulceration, extending 2 to 3 mm out on the vocal cord The mucous membrane of the left vocal process, the posterior part of the vocal cord and the right half of the interarytenoid region was slightly granular, without macroscopic ulceration

Microscopic Examination—Sections from the right vocal process showed a fairly large, superficial, nonundermined ulceration covered by a thin layer of fibrinopurulent exudate Especially corresponding to this area, the connective tissue stroma, with somewhat cadaverous changes, showed many partly confluent accumulations of epithelioid cells with necrosis, scattered Langhans giant cells and pronounced accumulation of lymphocytes Similar but less pronounced specific inflammatory processes were seen beneath the preserved part of the squamous epithelium In some places, these changes extended down to the cartilage, which, however, appeared not to be affected

The histologic diagnosis was tuberculosis of the right vocal process with extensive ulceration

CASE 6—A male factory worker, aged 38, died on March 19, 1945, of bilateral pulmonary tuberculosis with cavitation

Examination of the Larynx—On Nov 8, 1944 slight redness of the left vocal process and pale swelling of the left false vocal cord were observed There was a questionable pale infiltration of the interarytenoid region On Jan 8, 1945, there was still pronounced swelling of the left false vocal cord, with no definite abnormality in the interarytenoid region, edema and swelling of the left true vocal cord and still some redness of the left vocal process

Autopsy—The mucous membrane in the interarytenoid region was slightly granular. The left vocal process presented a small elongated ulceration, the right vocal cord was slightly thickened and nodular, without macroscopic ulceration.

Microscopic Examination—Sections from the left vocal process showed a small but deep ulceration, extremely undermined, it extended down under a piece of hyaline cartilage. The ulceration was limited by more or less necrotic granulation tissue, with a few areas of caseous necrosis and moderate epithelioid cell formation, no giant cells were observed.

The histologic diagnosis was tuberculosis of the left vocal process with ulceration.

CASE 7—A man aged 76, an artist, died on July 6, 1945, of tuberculosis of the left lung.

Examination of the Larynx—Monthly examinations were made during the last year before death, without demonstration of any abnormality. Owing to the poor state of the patient, however, examination was rather difficult during the last six months.

Autopsy—The left vocal process showed a superficial ulceration of lentil size. There was no other abnormality in the larynx.

Microscopic Examination—Sections from the left vocal process showed a rather large, slightly undermined ulceration, affecting the superficial layer of the hyaline cartilage, which was partly destroyed, and reactive leukocyte infiltration. In one of the sections, the marginal parts of the ulceration showed two small, though typical, heaps of epithelioid cells, in the same area, in another section, a single Langhans giant cell was seen. In addition, there was moderate round cell infiltration. There was no epithelial hyperplasia.

The histologic diagnosis was tuberculosis of the left vocal process with rather marked ulceration.

CASE 8—A man, aged 33, an office clerk, died on Sept. 29, 1945, of pulmonary tuberculosis of the right lung with cavitation and empyema.

Examination of Larynx—The mucous membrane of both vocal processes was slightly irregular and red on Jan. 31, 1944. On Sept. 13, 1945, slight swelling of the inferior surface of the left vocal cord was noted.

Autopsy—The left vocal process was the site of a frayed, rather superficial ulceration, which was not undermined and hardly the size of a lentil, there was no other abnormality of the larynx.

Microscopic Examination—Sections from the left vocal process showed a pronounced, rather superficial ulceration, slightly undermined on one side and bordered by a rather narrow zone of granulation tissue, with fibroblasts and thin-walled vessels. Among the inflammatory cells, lymphocytes were greatly preponderant, and since an area of necrosis was found at one side of the ulcer and two heaps of epithelioid cells, together with Langhans giant cells, were seen elsewhere in the specimen independent of the ulcer, the lesion most likely was of tuberculous nature, even though no unquestionable epithelioid cells were demonstrated in direct relation to the ulcer. No cartilage was seen in the specimen.

The histologic diagnosis was ulcer, presumably of tuberculous nature, of the left vocal process.

CASE 9—A man aged 36, an instrument maker, had a clinical diagnosis of pulmonary tuberculosis of the right lung with cavitation.

Examinations of Larynx—There were redness, swelling and probably ulceration of the left vocal process on Sept 26, 1941. On October 2, the mucous membrane of both vocal processes was intensely red and irregular, and the right side was swollen, in addition, on the left side was an area of depression. On October 9, examination revealed no abnormality of the posterior wall. On the right lateral wall the vocal process was red but not irregular or ulcerated, on the left lateral wall, the vocal process was intensely red, swollen and probably ulcerated. A fairly large piece of mucous membrane was excised from the left vocal process, a smaller piece from the right.

Microscopic Examination—The fragment of tissue from the right side was too small for diagnosis.

Sections from a piece of tissue, the size of a hempseed, from the left side showed a surface partly lined with stratified columnar epithelium, partly with stratified, normally differentiated squamous epithelium, from slight to medium thickness, noncornifying and slightly infiltrated with leukocytes. Corresponding to the transitional zone, the hyperemic, edematous connective tissue stroma showed several large, partly confluent, accumulations of epithelioid cells with slight necrosis and several Langhans giant cells, with rather marked lymphocytic infiltration in the surrounding tissue. There was a defect in the epithelium, presumably a true ulceration, but the vital reaction was strikingly slight, and no undermining was seen.

The histologic diagnosis was tuberculosis of the left vocal process, presumably with ulceration.

CASE 10—A man aged 31, a brewery worker, had a clinical diagnosis of tuberculosis of the left lung with cavitation and chronic alcoholism.

Examinations of the Larynx—On Dec 6, 1940 and on March 13, 1941 there were apparently no indications of abnormality at either examination. On Dec 13, 1941, the mucous membrane of both vocal processes was red, with marked irregular swelling. On Jan 9, 1942, examination revealed no abnormality of the posterior walls. The right and left walls showed granulations on both sides. Excision of tissue was made from both vocal processes.

Microscopic Examination—The specimen from the right vocal process was minimal, and its plane of section was unsuitable for examination for ulceration. No definite specific inflammatory changes were evident.

Sections from two pieces of tissue (from millet seed to hempseed size) from the left vocal process showed the surface to be lined with stratified, noncornifying, normally differentiated squamous epithelium of medium thickness, in some places permeated by quite a number of leukocytes. In one place a superficial, not undermined ulceration, of which the rather scanty granulation tissue was covered by a thick layer of fibrinopurulent exudate, reached the level of the epithelial surface. In the connective tissue stroma, which contained no cartilage or glands, a rather marked round cell infiltration was seen with a few partly necrotic accumulations of epithelioid cells, together with a single Langhans giant cell.

The histologic diagnosis was tuberculosis of the left vocal process with slight ulceration.

CASE 11—A man aged 60, a spinning-mill worker, had a clinical diagnosis of bilateral pulmonary tuberculosis.

Examination of Larynx—On Sept 27, 1943 both vocal cords were intensely red, somewhat swollen, with a slightly irregular margin, in particular posteriorly, where possibly there was some ulceration. On October 20, the redness subsided and was limited to the posterior part of the vocal cords. On November 3, there appeared to be possible ulceration of both vocal processes. On November 27, no

abnormality of the posterior wall was noted. On the right lateral wall the mucous membrane was somewhat red and swollen over the vocal process, where probably there was ulceration. On the left lateral wall, the vocal process was red and swollen, but without visible ulceration. An excision of tissue was made from the right vocal process.

Microscopic Examination—The surface of several small pieces of tissue was lined partially with stratified noncornifying squamous epithelium (thick to thin), with transition to stratified columnar epithelium. In particular, corresponding to the zones of transition, defects were found in the epithelial lining, and the connective tissue here showed extensive dark cellular streaks, as in chronic irritation. In addition, the connective tissue stroma was the site of several large accumulations of epithelioid cells with scattered giant cells of the Langhans type, and areas of necrosis here and there. Moderate round cell infiltration and granulation tissue formation were seen between the heaps of epithelioid cells. The fragments of tissue were torn too much for the establishment of definite, limited ulcerations. No cartilage or glands were seen in the fragments examined.

The histologic diagnosis was tuberculosis of the right vocal process, presumably with ulceration.

CASE 12—A man aged 45, a traffic clerk, had a clinical diagnosis of bilateral pulmonary tuberculosis with cavitation and diabetes mellitus.

Examination of Larynx—On Dec 1, 1943 there was an unquestionable pronounced irregular swelling and some redness of the left vocal process. On December 17 no abnormality of the posterior wall or of the right lateral wall was noted. On the left lateral wall the mucous membrane of the vocal process was thickened, with irregular granulations. Tissue was excised from the left vocal process.

Microscopic Examination—The fragment of tissue was hardly of millet seed size. Its surface was lined with a thin stratified, normally differentiated, noncornifying squamous epithelium, with transition to stratified columnar epithelium. There were noticeable round cell infiltration of the connective tissue stroma and several small accumulations of epithelioid cells, together with a single Langhans giant cell and slight necrosis. In several sections, at a certain point, the epithelial lining was very thin, and in one section, corresponding to this area, was a small superficial, not undermined ulceration covered by a layer of fibrin. No glands or cartilage were seen in the specimen.

The histologic diagnosis was tuberculosis of the left vocal process with slight ulceration.

CASE 13—A man aged 20, a cigarmaker, had a clinical diagnosis of bilateral pulmonary tuberculosis with cavitation.

Examination of Larynx—On Oct 22, 1944 the entire left vocal cord was slightly red, with congested vessels on the surface, there was distinct ulceration of the left vocal process, and perhaps also in the left angle, where the mucous membrane was somewhat red. On Jan 12, 1945, no abnormality of the posterior wall or of the right lateral wall was noted. On the left lateral wall the vocal process was pink, with ulceration. Tissue was excised from this area.

Microscopic Examination—Sections from two hardly pinhead-sized fragments of tissue showed the surface to be lined with stratified, moderately thick, normally differentiated, noncornifying squamous epithelium, permeated by many leukocytes. The extreme margin of one of these tissue fragments showed a part of a dish-shaped depression in the stroma, and there the epithelial lining was absent. The underlying tissue was the site of some necrosis, and numerous leukocytes were seen here. The rest of the stroma showed pronounced lymphocytic infiltration,

several Langhans giant cells and some epithelioid cell formation. The other tissue fragment was the site of distinct necrosis.

The histologic diagnosis was tuberculosis of the left vocal process, with ulceration.

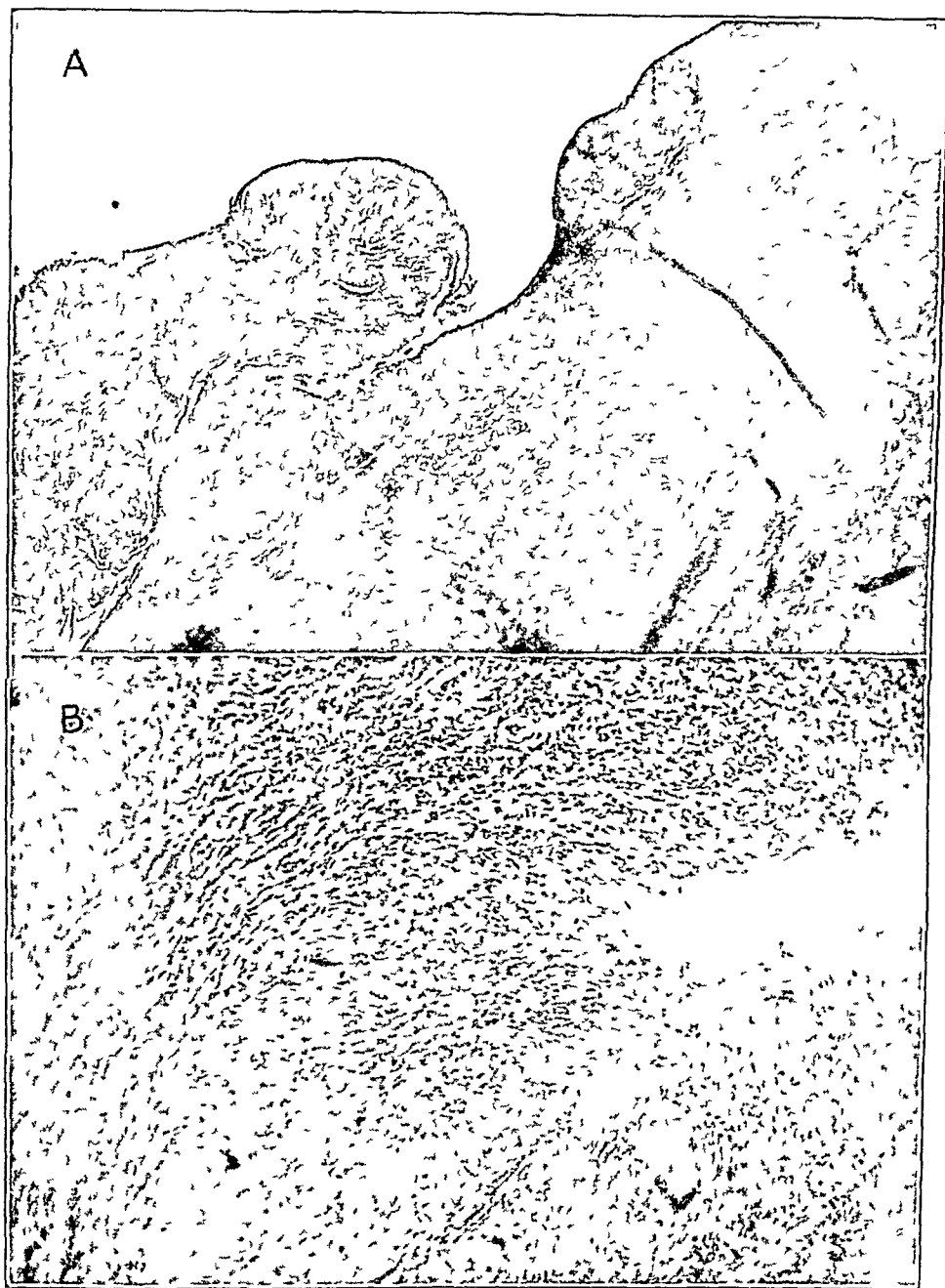


Fig 2 (case 14)—A, large undermined tuberculous ulcer of the vocal process, $\times 22$. B, floor of the ulcer with epithelioid cells, giant cells and necrosis, $\times 100$.

CASE 14—A man aged 78, an old age pensioner, died on March 14, 1946, of bilateral pulmonary tuberculosis.

Examination of Larynx—There was some redness of the posterior part of the left vocal cord, probably ulceration of the left vocal process, on Sept 20,

1945 On October 29, no abnormality of the posterior wall or of the right lateral wall was observed. On the left lateral wall there was infiltration of the left vocal process with superficial ulceration. An excision of tissue was made from the left vocal process. This, however, showed merely pronounced unspecific inflammation. Subsequent laryngoscopic examinations showed the same features that were seen on October 29.

Autopsy—On the left vocal process there was an oval, rather deep, slightly undermined ulceration, hardly the size of a hempseed, extending a little onto the vocal cord (fig 2).

Microscopic Examination—Sections from the left vocal process showed a deep, decidedly undermined ulceration, with destruction of the perichondrium and involvement of the superficial layer of the hyaline cartilage, which had undergone pronounced calcification. The ulceration was limited by abundant granulation tissue, richly vascularized and containing several large confluent accumulations of epithelioid cells, with areas of necrosis and Langhans giant cells (fig 2B). Beneath the preserved epithelium were pronounced typical tuberculous changes, with several smaller accumulations of epithelioid cells, slight necrosis, Langhans giant cells and rather noticeable round cell infiltration.

The histologic diagnosis was tuberculosis of the left vocal process, with ulceration.

CASE 15—A man aged 22, a bookbinder, died on Sept 10, 1944, of bilateral pulmonary tuberculosis and intestinal tuberculosis.

Examination of Larynx—On June 3, 1944 slight redness and irregular swelling of the left vocal process were noted, these conditions were observed also on August 3.

Autopsy—The left vocal process was the site of a rather deep oval ulceration, a little larger than a hempseed, extending a little onto the true vocal cord.

Microscopic Examination—The surface was lined with stratified squamous epithelium. In one place there was a rather large, slightly undermined ulceration with a slightly irregularly wavy floor. Superficially, there was a layer of fibrinopurulent exudate, covering partly necrotic and partly well preserved granulation tissue. To a rather large extent, the surrounding tissue was the site of infiltration of leukocytes and lymphocytes. The ulceration also affected the superficial layer of the cartilage. One of the sections showed a few small but unquestionable heaps of epithelioid cells, no giant cells or areas of necrosis were noted.

The histologic diagnosis was tuberculosis of the left vocal process to a slight degree, with pronounced ulceration.

CASE 16—A man aged 24, a fireman, died on Oct 21, 1942, of bilateral pulmonary tuberculosis.

Examination of Larynx—During the first part of the patient's stay in the hospital, laryngoscopy was out of the question. On Sept 25, 1942 a slight redness was noted, particularly in the posterior part. On October 20, a large ulceration was observed posteriorly on the right side of the larynx, with a fissure running along the margin of the right vocal cord.

Autopsy—Corresponding to the area of the right vocal process was an ulceration almost the size of a pea.

Microscopic Examination—Sections from a block of tissue, the size of a bean, from the right vocal process showed the surface to be lined with stratified, normally differentiated, noncornifying squamous epithelium. Over a rather large area the epithelium was sloughed off, and in the area corresponding to it, there was abundant, moderately protruding granulation tissue without specific changes. In other areas a rather pronounced subepithelial accumulation of lymphocytes

was seen, with a few large heaps of epithelioid cells and typical Langhans giant cells. Deeper in the tissue, mucous glands and striated muscle fibers were seen, without inflammatory changes. In all the sections the specific tissue changes were located strikingly far from the ulceration and the granulation tissue.

The histologic diagnosis was tuberculosis of the right vocal process, with a subchronic ulcer of this process.

CASE 17—A woman aged 67, an old age pensioner, died on Sept 20, 1944, of bilateral pulmonary tuberculosis.

Examination of Larynx—No definite abnormality was seen at an examination made on Sept 13, 1944 with the patient in bed.

Autopsy—The left vocal process presented a rather deep ulceration, a little larger than a hempseed. A small superficial defect in the mucous membrane was seen in the middle of the interarytenoid region.

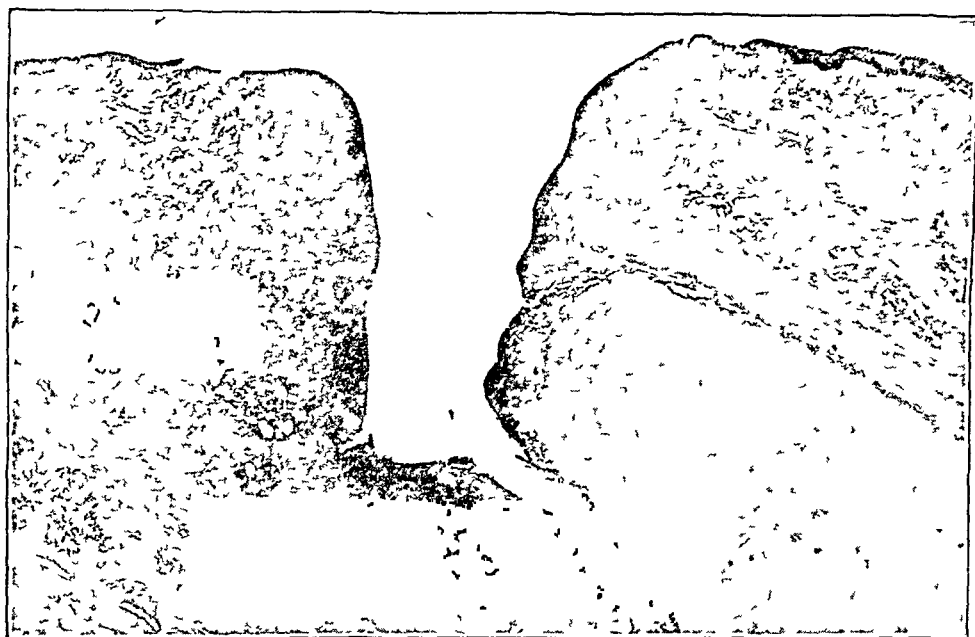


Fig 3 (case 18)—Large unspecific ulcer of the vocal process, $\times 22$

Microscopic Examination—Sections from the left vocal process showed a single deep, strongly undermined ulceration that affected the cartilage. In the surrounding areas were noted pronounced, chiefly exudative inflammatory processes. Most of the inflammatory cells were lymphocytes and plasma cells, but a few leukocytes were also seen. In close relation to the cartilage was a single small roundish heap of rather light, slightly elongated cells. They were not quite typical epithelioid cells, such cells were not demonstrable in any of the sections, nor were giant cells or areas of necrosis seen. This heap of cells suggested tuberculosis, but the changes were too scanty and too atypical for a definite diagnosis.

The histologic diagnosis was subchronic ulcer of the left vocal process (tuberculosis?).

CASE 18—A man aged 34, a shoemaker, with schizophrenia, died on Oct 11, 1945, of an abscess of the right lung and empyema of the right pleural cavity.

No tubercle bacilli had been demonstrated in the sputum. On admission, the patient was not well enough for laryngoscopy, bronchoscopy was also not performed.

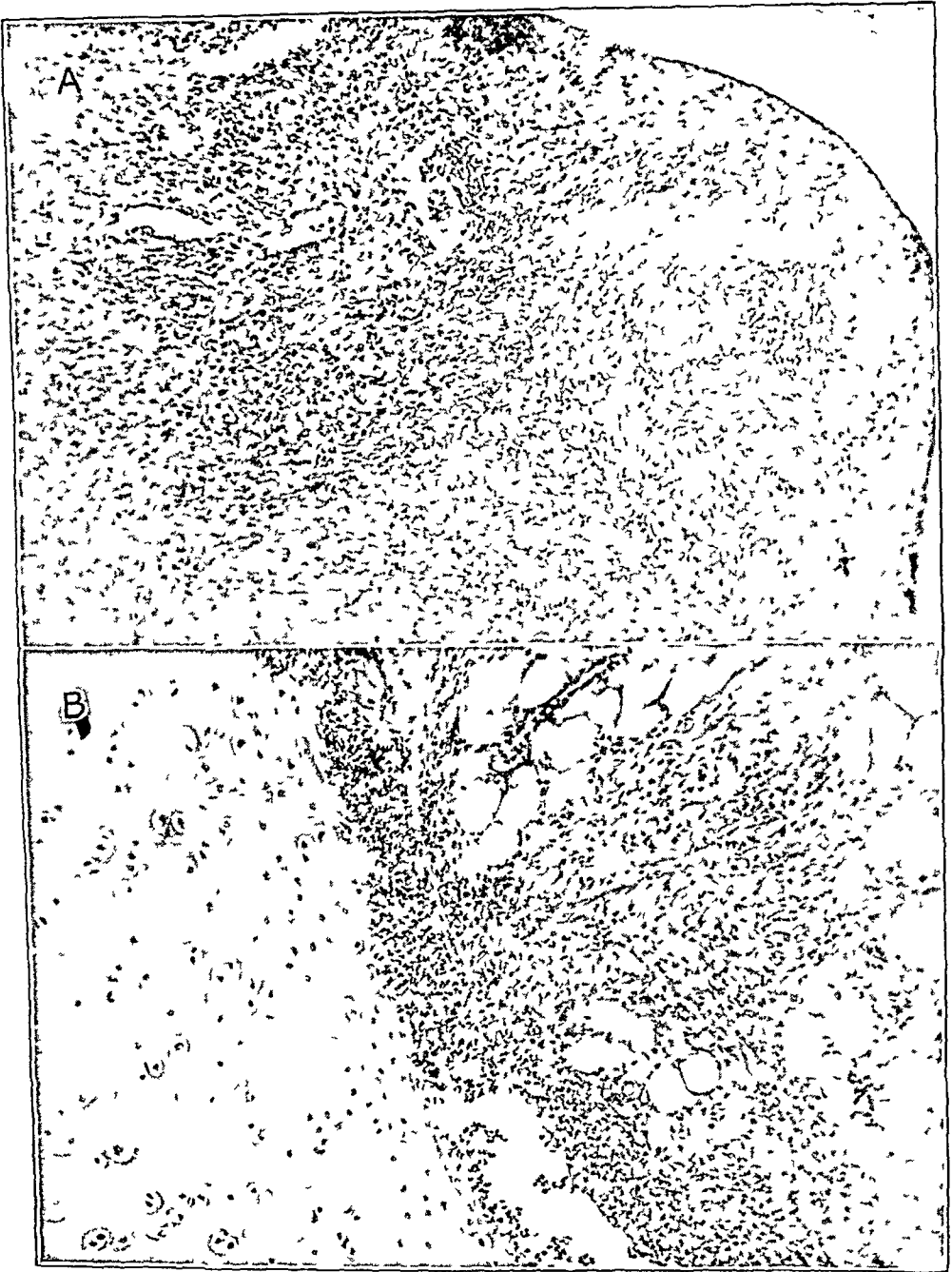


Fig 4 (case 18)—A, floor of the ulcer with fibrinopurulent exudate and unspecific granulation tissue. B, unspecific inflammatory changes around the cartilage, $\times 100$.

Autopsy—On the upper margin of the left vocal process, there was a slightly undermined, sharp-edged, deep ulceration (a little larger than a lentil), presumably affecting the cartilage too. No evidence of tuberculosis was seen in any of the other organs.

Microscopic Examination—In sections from the left vocal process the surface was found to be lined with stratified columnar epithelium, with transition to stratified, thin, normally differentiated, noncornifying squamous epithelium. Subepithelially, throughout the sections there was slight to moderate round cell infiltration. The inflammatory processes did not extend down into the numerous glands. In one place there was a deep, not undermined, ulceration showing beginning detachment and destruction of the cartilage. The floor of the ulcer was covered by fibrinous masses with an admixture of red and white blood cells. There was a slight proliferation of connective tissue in the surrounding areas, but only moderate granulation tissue formation. There was no evidence of tuberculosis.

The histologic diagnosis was subacute ulcer of the left vocal process, with subchronic inflammation of this process.

CASE 19—A man aged 50, a chauffeur, died on Dec 28, 1945, after an operation for bronchiectasis of the left lung. No tubercle bacilli were demonstrated in the sputum.

Examination of Larynx—On Dec 22, 1945, in the department of pulmonary surgery, direct bronchoscopy was performed without any abnormality of the vocal cords being observed. However, no particular attention was paid to the vocal processes.

Autopsy—The right vocal process was the site of an elongated, deep, undermined ulceration, nearly the size of a hempseed, that extended a little onto the true vocal cord. On the left vocal process the mucous membrane was decidedly hyperemic and slightly frayed over an area a little larger than a hempseed. No sign of tuberculosis was found anywhere in the other organs.

Microscopic Examination—The preparation of the left vocal process was unsuccessful. Sections from the right vocal process showed a medium-sized defect in the epithelial lining and, corresponding to it, a rather thick layer of fibrin, beneath which the connective tissue stroma was edematous, with dilatation of the blood vessels and rather definite infiltration with leukocytes, besides some lymphocytes. The inflammatory changes did not quite extend to the cartilage but expanded somewhat beneath the epithelium. There the round cell infiltration was more conspicuous. No particular loss of substance corresponding to the area of ulceration was seen, nor any granulation tissue proper. There was no evidence of tuberculosis. Sections from the lung showed no sign of tuberculosis. The histologic diagnosis was acute ulcer of the right vocal process, with subacute inflammation.

COMMENT

Of the 17 patients with pulmonary tuberculosis (cases 1 to 17) in whom contact ulcers have been demonstrated, we have been able to show histologically that no less than 14 (cases 1 to 7 and 9 to 15) presented unquestionable tuberculous ulcerations. In 2 patients (cases 8 and 16) the specific changes were located strikingly far from the ulceration itself and the granulation tissue, and hence their etiologic unity seems somewhat uncertain. Finally, in 1 patient (case 17) the specific changes were so scanty and so little typical that the diagnosis of tuberculosis could not be made with certainty.

In the 2 patients who did not have pulmonary tuberculosis (cases 18 and 19), the histologic examination showed the ulcers to be typically unspecific

All the 17 tuberculous patients in whom contact ulcers were demonstrated had had severe pulmonary lesions, with masses of tubercle bacilli in the sputum. Of these patients, 15 were men and 2 were women, aged 20 to 78. For 12 (cases 1 to 8 and 14 to 17), the histologic diagnosis was made on the basis of autopsy specimens, while for the remaining 5 (cases 9 to 13) it was made on the basis of biopsy.

For 4 patients (2, 3, 7 and 17) any thorough laryngoscopy was out of the question, on account of their debility and, consequently, poor cooperation. In only about half of the remaining 13 patients had it been possible by indirect laryngoscopy (employment of *ter Kuile* mirrors included) to demonstrate ulcers of the vocal processes, while of the others, merely a description has been given of the formation of granulation tissue on the vocal processes, or only of the redness and swelling of the mucous membrane.

At autopsy far more ulcerations were demonstrated macroscopically. When the ulcerations were not observed more frequently on mirror examination, it was undoubtedly because they were concealed by the granulation tissue, and, perhaps, also because examination with two mirrors used at the same time requires considerable experience. Nor is it to be wondered at that sometimes the examiner fails to recognize by means of mirrors the ulcerations that may be difficult, even at autopsy, to see with the naked eye.

The demonstrated ulcers of the vocal processes by no means may be said to have been a part of any extensive ulcerative or proliferative tuberculosis of the larynx, for in about two thirds of the cases the contact ulcer was the only demonstrable sign of laryngeal tuberculosis. In 3 patients there was simultaneous swelling of the corresponding vocal cord, 2 presented small granulations in the interarytenoid region, and, finally, 1 showed in this region slight defect (that is, very scanty changes) of the mucous membrane. It should be kept in mind that autopsy was performed in two thirds of the cases, and the larynx, cut open anteriorly, was examined thoroughly, with a special view to observing the presence of tuberculous changes in places other than in the vocal processes.

It has long been realized that laryngeal tuberculosis may manifest itself only in ulceration of the vocal process. Thus, as early as 1890, Fraenkel⁶ stated that examination of 16 patients with laryngeal tuberculosis, who died of pulmonary tuberculosis, revealed ulcerations on

6 Fraenkel, E. Untersuchungen über die Aetiologie der Kehlkopftuberculose, *Virchows Arch f path Anat* **121** 523, 1890

the vocal process, and in 5 of these 7 it was the only demonstrable evidence of laryngeal tuberculosis

So both the findings reported by Fraenkel⁶ and our own findings in the present material are in conflict with a statement made in the Jackson and Jackson⁷ textbook

Tuberculous ulcers are not limited to the area above mentioned for contact ulcer, the accompanying pallor of the mucosa, the turban epiglottis, the pyriform ary-epiglottic folds and the interarytenoid ulcer give a picture that in no way resembles that of contact ulcer

We believe that a contact ulcer may well be—and often is—the only manifestation of tuberculosis in the larynx

Considering the sex distribution of the patients, it is a striking fact that this lesion occurs predominantly in men, the ratio of men to women in the present material being 15 to 2. This fact has also been emphasized by Jackson and Jackson,⁷ who stated that the disease is encountered almost exclusively in men. Within the five year period from which our material originates, a practically equal number of men and women have been admitted with pulmonary tuberculosis, so that the character of the patient material does not explain the great difference in the sex distribution. As reported by Blegvad⁸ from observations made during the period from 1916 to 1934 in the ear, nose and throat clinic of the Øresund Hospital, practically the same number of men and women have been treated for all forms of laryngeal tuberculosis. Earlier statistics show the ratio between men and women for this lesion to be 2:1 or 3:1 (Mayer,⁹ Brauch¹⁰). Thomson¹¹ found the same sex distribution as did Blegvad. The latest investigations by Myerson¹² and Wilson¹³ date from 1939 and 1941, respectively. In a series of 1,000 patients each, both of these authors found the ratio of men to women with laryngeal tuberculosis to be 1:3 to 1.

7 Jackson, C, and Jackson, C L. Diseases and Injuries of the Larynx. A Textbook for Students and Practitioners, ed 2, New York, The Macmillan Company, 1942, pp 169-170

8 Blegvad, N R. Remarks on the Tuberculosis of the Larynx, *Forhandl nord Tuberc-lægeforen*, 1935, p 196

9 Mayer, E. Die Tuberculose der oberen Luftwege, in Denker, A, and Kahler, O. *Handbuch der Hals-Nasen-Ohren-Heilkunde*, Berlin, Julius Springer, 1926, vol 4, p 83

10 Brauch, M. Klinisch-statistische Beiträge zur Frage der Kehlkopf Phthuse, *Monatsschr f Ohrenh* 55 230, 1921

11 Thomson, St C. The Prognostic Importance of Tuberculosis of the Larynx, *Acta oto-laryng* 2.105, 1920

12 Myerson, M C. Some Phases of Tuberculosis of the Larynx, *Ann Otol, Rhin & Laryng* 48 707, 1939

13 Wilson, G E. Diagnosis and Treatment of Tuberculosis of the Larynx and Contiguous Areas, *Arch Otolaryng* 33 145 (Feb) 1941

Thus, the sex distribution of tuberculous contact ulcers in patients with pulmonary tuberculosis deviates considerably from that of laryngeal tuberculosis, when all forms of this lesion are considered. On the other hand, the sex distribution in this series was nearly the same as that found for contact ulcers in nontuberculous patients. This might be taken to suggest that etiologic factors of these ulcerations in tuberculous patients are analogous to those of unspecific contact ulcers—e g., excessive use of the voice or damage from alcohol and tobacco.

As the most important etiologic factor in the appearance of contact ulcer, Chevalier Jackson¹⁴ emphasizes the hammer-anvil effect of the two vocal processes on quantitative or qualitative abuse of the voice. In the hospitalized, often exhausted, tuberculous patients an abuse of the voice is not likely to happen as often as when they are outside the hospital. On the other hand, the often violent, protracted and refractory cough may perhaps produce a somewhat similar mechanical strain on the thin mucous membrane lining the vocal processes as that which results from abuse of the voice. Furthermore, perhaps, in the often debilitated patient, the mucous membrane is less resistant because of a deficiency of vitamin A and B (resulting in painful deglutition) or because of dehydration.

Another etiologic factor emphasized by Chevalier Jackson is the presence of chronic infections in the sinuses and in the nasopharynx, with continuous flow of secretion to the throat. In tuberculous patients this is replaced by the abundant expectoration, which in bedridden patients often seems to cover the posterior part of the larynx.

While these factors may explain the appearance of the ulcers in the posterior part of the larynx, they offer no explanation of the great difference in the sex distribution of the patients in the present material. It must be assumed that the cough and the amount of secretion are not particularly different in men and women. The only relevant factor, perhaps, that may differ to some extent in men and women is inhalation of tobacco smoke, which undoubtedly is more prevalent among men. Furthermore, the possibility cannot be excluded that abuse of the voice had taken place prior to the establishment of the pulmonary tuberculosis and before the appearance of the laryngeal tuberculosis, thus establishing a *locus minoris resistentiae* on the vocal processes.

As to the manner of origin of laryngeal tuberculosis, we believe that the theory of sputogenous infection is the prevailing one today, even though a few cases of solitary laryngeal tuberculosis have been reported. Thus, in the Danish Society of Otolaryngology, Strandberg¹⁵ has

¹⁴ Jackson¹ Jackson and Jackson⁷

¹⁵ Strandberg, O. Nogle tilfælde af isoleret larynxtuberculose, Dansk m. selsk. Forhandl., 1934, p. 77

reported 4 cases of solitary laryngeal tuberculosis (though not particularly contact ulcers) He pointed out himself, however, that only by autopsy can tuberculosis elsewhere in the organism be excluded In only 1 of his cases was autopsy performed, the presence of tubercle bacilli had been demonstrated in the gastric lavage, and, besides, roentgenography had suggested the presence of pulmonary tuberculosis No observations or microscopic examination of the lungs were recorded

In a discussion of the pathogenesis of tuberculous contact ulcers, the previously mentioned mechanical factor cannot be left out of consideration The morbid process may result from an initially unspecific contact ulcer, which secondarily becomes infected from the bacilli-containing sputum, or the primary feature may consist of subepithelial elementary tubercles on the vocal processes, subsequently ulcerating through the mucous membrane in response to the aforementioned traumatic influences Thus, we would be dealing with primarily tuberculous ulceration

The appearance of such tuberculous elements beneath an apparently intact mucous membrane is well known elsewhere in the larynx, these elements arising from bacillary invasion through minute breaks in the continuity of the mucosal epithelium, through the excretory ducts of the glands or, perhaps, through the intact epithelium too—similar to what has been observed elsewhere in the organism, e g, in the intestine The histologic examinations here reported showed often very scanty tuberculous changes, since frequently the diagnosis was established only through serial section of the specimens involved At first this might suggest that in such cases we were faced by poorly developed secondary infections From experience we know, however, that also in case of ulcerations elsewhere in the larynx, where the mechanical factor does not assert itself, it may be difficult to demonstrate the tuberculous elements As a matter of fact, this is true also of the rather rare nasal tuberculosis Finally, in biopsy of the vocal processes in cases in which the mucous membrane was red and swollen, we have often found tuberculous changes beneath normal, nonulcerating epithelium

Hence it seems reasonable to assume that in these ulcerations on the vocal processes one is dealing with a condition of subepithelial tuberculosis in which the ulceration is promoted by mechanical factors, in keeping with the view presented by Hart and Mayer¹⁶ that catarrhal and mechanical damage to the mucous membrane promotes and is a condition essential to tuberculous changes in this structure

16 Hart, C, and Mayer, E *Spezifische Entzündung der Kehlkopf*, in Henke, F, and Lubarsch, O *Handbuch der speziellen pathologischen Anatomie und Histologie*, Berlin, Julius Springer, 1928, vol 3, pt 1, p 401

Perhaps the great frequency of tuberculous processes in the patients with contact ulcers here reported on may be accidental and a review of other, and possibly larger, series of tuberculous patients may show unquestionably unspecific ulcerations on the vocal processes. But although Chevalier Jackson¹ reported 2 cases of unspecific contact ulcers in patients with pulmonary tuberculosis in whom the ulcers finally became tuberculous, we are more inclined to believe that from the very start these ulcers had been tuberculous and that the histologic diagnosis had been difficult, as is often the case.

Of course, it is conceivable that contact ulcers apparently heal under prolonged economizing of the voice, while at the same time the presence of tuberculous ulcerations elsewhere in the larynx remains unnoticed, but this does not necessarily prove that the ulceration on the vocal process was nontuberculous.

Although Peroni¹⁷ was unable, in an autopsy specimen from a tuberculous patient, to demonstrate any tuberculous changes in a contact ulcer, no decisive significance is to be assigned to this negative observation unless a serial section of the specimen was made.

In the 2 patients who died of nontuberculous lesions (cases 18 and 19) autopsy revealed clearcut contact ulcers, and in both the histologic examination showed simple unspecific inflammatory changes, as recorded. As to the cause in 1 case (case 19) we probably cannot quite exclude the possibility that the bronchoscopy performed six days before the patient died may have produced an injury to the mucous membrane with subsequent inflammatory changes—particularly since the microscopic changes observed had to be characterized as being recent.

In order to elucidate whether ulcerations on the vocal processes are particularly frequent in debilitated persons with lowered resistance, a thorough examination was made of the larynx from fifty successive autopsies, taken at the old people's home. In this way we found no less than 2 instances of contact ulcers of the larynx (cases 20 and 21).

CASE 20—A man aged 75, an old age pensioner, died on Jan 26, 1946, of bilateral bronchopneumonia. In addition, he had a severe cardiac lesion and atherosclerosis. There had been practically no cough. Laryngoscopy was not performed, and no mention was made in the case record about hoarseness.

Autopsy—The right vocal process presented a superficial, not undermined, ulceration, about 3 mm long and 1 mm wide. Otherwise the larynx appeared normal. No sign of tuberculosis was observed in any of the organs.

¹⁷ Peroni, A. Contact Ulcer of the Larynx. Pathologic Observations, Arch Otolaryng 17 741 (June) 1933.

Microscopic Examination—Sections from the right vocal process showed a dish-shaped depression, the marginal zone of which was lined with stratified squamous epithelium, whereas on the areas corresponding to the floor of the ulcer there was an epithelial defect bordered by leukocyte-containing fibrin and a scanty amount of granulation tissue. The upper layer of the perichondrium was also affected. There was no evidence of necrosis, proliferation of connective tissue or cicatricial changes. Apart from the ulceration, the squamous epithelium was normal throughout, of medium thickness and neither cornifying nor parakeratotic. Subepithelially there was extensive round cell infiltration which did not involve the glands. The inflammatory changes were not strikingly pronounced, corresponding to the site of ulceration, and there was no evidence of tuberculosis.

The histologic diagnosis was subacute ulcer of the right vocal process, with subchronic inflammation (fig 5).



Fig 5 (case 20)—Unspecific ulcer of the vocal process, $\times 100$

CASE 21—A man aged 84, an old age pensioner, with senile dementia, died on March 30, 1946, of bronchopneumonia. There had been no annoying cough or hoarseness. In the last week before his death, a decubitus ulcer developed over the sacrum. Laryngoscopy was not performed.

Autopsy—The left vocal process was the site of a rather deep, not undermined, ulceration measuring 4 by 2 mm. The cartilage was not bared. The right vocal process showed a more superficial ulceration not undermined and measuring 3 by 1 mm. The rest of the larynx appeared normal. There was no evidence of tuberculosis in any organ.

Microscopic Examination—In sections from the left vocal process the surface was found to be lined with a somewhat thickened, noncornifying, squamous epithelium, in some places decidedly keratotic. Here and there the basal border was somewhat scalloped, but sharply defined throughout. The differentiation of the cells was normal. No cellular polymorphism or nuclear atypia was seen.

There was no increase in the number of mitotic figures. In one place, where the epithelium was of normal thickness, a rather large ulceration was seen, bordered by a fairly wide zone of rather young, richly vascularized granulation tissue containing numerous newly formed, thin-walled capillaries and a considerable number of inflammatory cells, lymphocytes as well as leukocytes. The granulation tissue extended down into the superficial layers of the cartilage, there was no proliferation of connective tissue. In several places there was an extensive subepithelial round cell infiltration, this was most pronounced in the vicinity of the ulceration, where there was also some hyperemia. The glands were practically unaffected, and there was no evidence of tuberculosis.

Sections from the right vocal process showed the same changes, qualitatively, as were found on the left side, even though the inflammatory processes were less pronounced there, the ulceration less extensive and the cartilage intact. There was no sign of tuberculosis.

The histologic diagnosis was subacute ulcer of both vocal processes with subchronic inflammation, squamous epithelial hyperplasia, parakeratosis.

In these 2 patients (cases 20 and 21), as well as in 2 others (cases 18 and 19) the ulcerations were thus associated with unspecific inflammatory changes. The group from which the 50 larynxes were examined was made up of old persons, all with atherosclerosis, often to an extreme degree, hence it is reasonable to assume that the resistance of the tissues had been impaired, this may possibly explain why no less than 4 per cent of the specimens examined showed the presence of contact ulcers. In these old people, we believe, the lesions on the vocal processes are undoubtedly to be looked on as a sort of decubitus ulcer.

SUMMARY AND CONCLUSION

The present material comprises 21 cases of contact ulcers of the larynx. Autopsy was performed in 16 of these.

In 14 of the 17 patients with pulmonary tuberculosis, the contact ulcers were found with certainty to have been tuberculous, and very likely to have been tuberculous in 2, while for the remaining patients the diagnosis was more dubious.

Typical unspecific contact ulcers were demonstrated in 4 patients who had no pulmonary tuberculosis.

The contact ulcers of the larynx in old people are interpreted as being some sort of decubitus ulcer.

In contrast to the view prevailing hitherto, a tuberculous contact ulcer may well be the only sign of laryngeal tuberculosis, and hence a patient with contact ulcer is always to be suspected of having pulmonary tuberculosis until this is refuted.

BACITRACIN

Its Topical Use in Aural and Pharyngeal Infections

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RECENT advances in the treatment of infectious diseases, made possible by the discovery of bacteriostatic agents, have inspired medical investigators to study an ever increasing number of chemotherapeutic and antibiotic substances. Many different compounds have been isolated and tested in the laboratory and used clinically, but only a few of them have proved to be of definite value. The great majority have been unsatisfactory either because of their excessive toxicity or because of their failure to act specifically on the organism for which an inhibiting substance was being sought.

It is our purpose in this paper to report additional studies with a relatively new antibiotic agent, bacitracin. Bacitracin was first reported by Johnson, Anker and Meleney,¹ in 1945. It had been produced by a strain of *Bacillus subtilis* recovered from a mixture of organisms contaminating the débrided tissue removed from a compound tibial fracture. After having investigated the properties of the substance sufficiently in the laboratory, Meleney and Johnson² in 1947 gave the first clinical report concerning bacitracin as used locally in surgical infections.

Inasmuch as bacitracin possessed definite bacteriostatic properties, and appeared to be nontoxic when applied locally, we decided to conduct a clinical and bacteriologic investigation of infections of the ear and the pharynx treated with this substance. Bacitracin was administered topically in aural infections in the form of a solution made by adding triple-distilled water to the crystalline product in proportions desired for a particular strength. The initial concentration was 100

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1 Johnson, B A, Anker, H, and Meleney, F L. *Science* **102** 376, 1945.

2 Meleney, F L, and Johnston, B. *Bacitracin Therapy*, *J A M A* **133** 675 (March 8) 1947.

Units per cubic centimeter, but later the concentration was increased in accordance with the severity of the infection and its clinical response

(A recent communication from the manufacturer states that bacitracin is more effective when used in an isotonic solution of sodium chloride) In the treatment of the pharyngitides the topical application of bacitracin was accomplished through the use of lozenges, each containing 1,000 units of the drug The base consisted of powdered sugar, tragacanth, glycyrrhiza, magnesium stearate, anise oil and coriander oil

CLINICAL METHODS AND OBSERVATIONS

Procedure—Two groups of patients were investigated The first consisted of 29 patients complaining of symptoms referable to the pharynx and/or tonsils Eight of these patients, serving as controls, were treated with saline gargles every three hours and 10 grains (0.65 Gm) of acetylsalicylic acid four times daily One control patient was given bacitracin later, because of continued symptoms The remaining 21 patients were treated with bacitracin lozenges exclusively Originally the members of this group were instructed to hold a lozenge in the buccal sulcus until dissolution took place This process proved to be too slow, however, and subsequent patients were encouraged to suck the compound

The second group, 22 patients, were those with infections of the external auditory canal, of the middle ear, of the middle ear and mastoid process or of the cavity produced by mastoidectomy In the last category were 8 patients on whom the fenestration operation had been performed There were no controls in this series, but each patient had been previously treated locally without success by other means in common use in our clinic The first few patients received a solution containing 100 units per cubic centimeter, but the majority of them were treated with a solution of twice this concentration The quantity varied with each patient, since an amount sufficient to fill completely the external auditory canal and middle ear or mastoidectomy cavity was used The patient was instructed to use the solution three times daily The ear was mechanically cleansed only when the patient presented himself at the clinic for reexamination

Specimens were taken for bacteriologic examination at the initial appearance of the patient and at each subsequent visit A sterile cotton applicator was wiped over or inserted into the involved region in an effort to obtain a specimen from any exudate or discharge and then placed into a test tube containing 5 cc of sterile isotonic sodium chloride solution The tubes were labeled by number only, immediately refrigerated at 5 C and sent to the bacteriologic laboratory within twenty-four hours

Observations—In general, bacitracin was well tolerated both in solution and in lozenge form No unfavorable reactions were noted in any of the patients The majority of them considered the lozenge mildly unpleasant to taste, but only 2 failed to continue the treatment in accordance with instructions

The average patient used 6 lozenges orally each day, a total of 6,000 units The average quantity used in aural infections was 1.5 to 2 cc of solution containing 200 units per cubic centimeter for each instillation, or a total of 900 to 1,200 units daily

The results of the therapy were classified as good, fair, poor, unknown or unsatisfactory. As stated before, there were no unfavorable reactions to the drug.

The clinical response of the pharyngitides to bacitracin lozenges was difficult to evaluate, because of the necessity of relying on the patient's subjective reactions and the dearth of objective clinical findings. An additional factor was the large percentage of patients who did not return for reexaminations. This was particularly true of the control group, in which 5 of the 8 patients did not return for evaluation of their treatment.

The best results were noted in cases of acute and chronic pharyngitis, 70 per cent of the patients with acute and 100 per cent of those

TABLE 1—*Response of the Pharyngitides Treated with Bacitracin Lozenges*

	Number of Cases	Cases in Which Results Were			
		Good	Fair	Poor	Unknown
Acute pharyngitis	13	9	2	0	2
Control acute pharyngitis	8	1	1	1	5
Chronic pharyngitis	2	2	0	0	0
Acute tonsillitis and pharyngitis	3	2	0	1	0
Acute follicular tonsillitis	2	1	0	1	0
Acute lingual tonsillitis	1	0	0	0	1

TABLE 2—*Results of Treating Aural Infection Topically with Bacitracin*

	Number of Cases	Cases in Which Results Were				
		Good	Fair	Poor	Unknown	Unsatisfactory
Fenestration cavity	8	4	2	1	0	1
Chronic external otitis	10	4	0	6	0	0
Chronic suppurative otitis media	3	0	0	3	0	0
Suppurating mastoid cavity	1	0	0	0	1	0

with chronic pharyngitis responded favorably to the drug. The poorest results were found in those patients who had extensive pharyngeal disease with severe constitutional reactions. The results are summarized in table 1.

Infections of the auricle, on the other hand, lent themselves more readily to interpretation and to evaluation of the effect of bacitracin, because of the objectivity of the signs of disease. Generally speaking, the best results were obtained in the treatment of infected fenestration cavities, wherein 75 per cent of the patients showed a good or a fair response to the agent after other measures had failed. As might be expected, the poorest results were found in cases of chronic suppurative otitis media and mastoiditis. The failures were 100 per cent in this group. The response in chronic external otitis was likewise disappointing in that only 40 per cent of the patients appeared to have benefited by this form of treatment. The results are summarized in table 2.

BACTERIOLOGIC METHODS AND RESULTS

Methods—The specimens taken on moist swabs were shaken in 10 cc of 0.85 per cent sodium chloride solution when received at the laboratory. To neutralize the bacitracin present in the specimen, 0.1 cc of 1 per cent sodium thiosulfate was added to the 10 cc of saline solution containing the specimen. An aliquot 0.1 cc of the sample was placed on a blood agar plate and spread with a bent glass rod. The same spreader was used to streak a second blood agar plate.

After forty-eight hours' incubation, the plates were examined and records made of the number of different forms as indicated by colony size, shape, form, etc. Microscopic examinations were made, as were subcultures to brain-heart infusion broth and phenol red-mannitol-agar slants. The susceptibility of the

TABLE 3—*Incidence of Bacitracin and Penicillin Susceptible Strains of Bacteria Isolated from Various Types of Infection*

Type of Infection	Staphylo cocci		Hemolytic Strepto cocci		Non-hemolytic Streptococci		Viridans Strepto cocci		Gram Negative Diplococci		Gram Negative Diplococci		Gram Negative Rods		Gram Negative Rods	
	B	P	B	P	B	P	B	P	B	P	B	P	B	P	B	P
Acute pharyngitis	31% (16)*	31%	0% (3)	0%	54% (13)	31%	33% (7)†	50%	0% (2)	0%	0% (2)	0%	33% (5)‡	33%	0% (1)	0%
Acute tonsillitis	57% (7)	71%	(0)	(0)	55% (10)	67%	(2)§	(2)	(1)§	(1)	0% (1)	100%	0% (3)	0%	(0)	(0)
Control	50% (4)	75%	50% (2)	100%	33% (3)	0%	0% (3)	0%	33% (3)	67%	0% (1)	100%	(0)	(0)	(0)	(0)
Chronic pharyngitis and tonsillitis	50% (2)	50%	0% (3)	0%	60% (5)	40%	0% (1)	0%	100% (3)	67%	(0)	(0)	(0)	(0)	(0)	(0)
External otitis	50% (2)	50%	(0)	(0)	0% (1)	0%	(1)—	(1)	100% (4)	75%	0% (4)	0%	0% (2)	0%	0% (15)	0%
Chronic otitis media	100% (1)	100%	(0)	(0)	0% (1)	0%	(0)	(0)	0% (2)	0%	0% (2)	0%	0% (3)	0%	0% (5)	0%
Penetration cavity infection	22% (9)	56%	(0)	(0)	100% (1)	100%	(0)	(0)	40% (5)	60%	(0)	(0)	0% (1)	0%	(0)	(0)
Fermenter of mannitol	70% (37)		88% (8)		43% (30)		36% (11)		67% (18)		33% (10)		40% (10)		19% (21)	

* The number in parentheses indicates the number of strains studied. Above it are the percentages susceptible to bacitracin (B) and to penicillin (P).

† One was not tested.

‡ Two were not tested.

§ Not tested.

organisms to bacitracin, 10, 0.2, 0.1, 0.01 and 0.001 unit, and penicillin 10 unit, was tested. Controls were run with each group of isolated organisms, using the standard P209 strain of staphylococci.

Results—The results recorded in table 3 indicate the types of organisms isolated from 51 patients supplying 106 specimens. It seemed more desirable to study the susceptibility or resistance of these organisms to the bacitracin and, for comparison, to penicillin than to identify and type the bacteria completely. Tests for fermentation of mannitol were routinely done as an indirect method of estimating the virulence of the staphylococci for man. It is of some interest to note that 7 of the 8 strains of hemolytic streptococci examined fermented mannitol.

A comparison of the relative degrees to which the organisms were susceptible to bacitracin and penicillin revealed instances in which organisms were susceptible to one drug but not to the other. The data given in table 3 comprise the findings on cultures from all specimens examined. Since several specimens from the same patient were studied on successive days, these data only approximate the percentage of patients from whom susceptible strains were isolated. It will be noted that from 30 to 50 per cent of the strains of staphylococci isolated were susceptible to bacitracin and a similar number to penicillin. Only a limited number of strains of hemolytic streptococci were studied. A further study of original data on the susceptibility of staphylococci revealed that 10 patients had strains susceptible to bacitracin but not to penicillin, 2 patients, strains susceptible to penicillin but not to bacitracin, 4, strains susceptible to both, and 7, strains susceptible to neither drug. These findings stress the need for several drugs from which

TABLE 4—*Bacitracin Susceptible or Resistant Bacteria in Specimens from Patients Receiving Bacitracin Local Therapy*

Response to Therapy	Number of Patients with Bacteria		
	Total	Some Susceptible	All Resistant
Good	22*	12†	9†
Fair	4	4	0
Poor	12	6	6
Questionable	6	3‡	2‡

*Included is 1 patient who had no relief as a control but who responded to bacitracin

† On culture had no growth

‡ There are no data for 1 specimen

to select by means of susceptibility tests the appropriate one for treating a given infectious disease.

The difficulty of correlating bacteriologic with clinical results in cases of infection of the upper respiratory tract arises from a lack of knowledge of which, if any, of the isolated organisms is probably the inciting etiologic factor in the disease. Hence it is not strange that table 4 reveals little correlation of clinical and bacteriologic data. It is of interest to note in regard to the majority of patients whose infections showed poor response to bacitracin that all the organisms isolated which might be the infecting agent were resistant to the drug. On the other hand, there was an equal distribution of susceptible and resistant organisms isolated from patients apparently helped by this therapy. If the etiologic agents were known, a better correlation might have been made.

SUMMARY AND CONCLUSIONS

Bacitracin was used topically in the treatment of aural and pharyngeal infections. There were 21 cases of pharyngeal and/or tonsillar infection and 22 cases of aural infections.

Eight patients served as controls for the bacitracin therapy of acute pharyngitis. There were no controls for that of aural infections, but each patient had been treated previously by other methods in common use in our clinic.

Bacteriologic cultures were made of material from the infected area in each case. The susceptibility of the harvested organisms to bacitracin was studied and then compared with that to penicillin.

The mannitol fermentation test was routinely done as an indirect method of estimating the virulence of the organisms for man.

Bacitracin was effective in the treatment of mild acute and chronic pharyngeal and tonsillar infections. It was not effective in severe infections of the area. Bacitracin was effective in the treatment of infections of the mastoidectomy cavity. The results were poor in cases of external otitis and chronic suppurative mastoiditis.

Correlation of clinical and bacteriologic data was difficult, particularly in regard to the pharyngitides, because of the difficulty of determining which, if any, of the isolated organisms was the probable etiologic factor in the disease.

Comparison of the relative degrees to which the organisms were susceptible to bacitracin and penicillin revealed instances in which organisms were susceptible to one drug but not to the other. In general, however, the studies of susceptibility revealed a similar effectiveness of each drug.

TRIBROMOETHANOL-ETHER ANESTHESIA USED FOR TONSILLECTOMY AND ADENOIDECTOMY

An Analysis of 3,042 Cases Over an Eight Year Period

STARLING C YINGER, M D

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IN THE PAST it has been customary to use general anesthesia for tonsillectomy and adenoidectomy in children but it is seldom used in adults. During 1939 my associates and I began using a combination of tribromoethanol with amylene hydrate (avertin®) to produce a basal anesthesia, following with ether by the open drop method, in patients of all ages. This report is based on 3,042 cases over an eight year period. The results have been so satisfactory that this has now become

TABLE 1—*Age Distribution of Patients*

Age Groups	
Up to 10 yr	1,390
10 to 20 yr	724
20 to 30 yr	420
30 to 40 yr	290
40 to 50 yr	146
50 to 60 yr	38
60 to 70 yr	31
70 yr and over	3
Total	3,042

a routine anesthetic procedure for practically all such operations in our hospital, there is now only a rare case in which an operation is performed with any other form of anesthesia.

The ages of patients undergoing operation for removal of the faucial tonsils or the adenoid or both have ranged from 5 months to 74 years. The age distribution is shown in table 1.

The advantages of this type of general anesthesia compared with other types are as follows. There is complete elimination of the state of anxiety shown by patients of all ages, and in the so-called nervous patient this is much to be desired. All patients are asleep when they leave their hospital rooms and have no recollection of being in the

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Thesis submitted to the Faculty of the Graduate School of Medicine of the University of Pennsylvania toward the requirements for the degree of master of Medical Science (M Sc [Med]) for graduate work in otolaryngology

operating room The amount of ether required to maintain surgical anesthesia for the duration of the operation is considerably less than would be used if tribromoethanol were not employed With the use of lesser amounts of ether, postoperative nausea and vomiting are at a minimum This anesthetic combination promotes no capillary bleeding as do certain gaseous anesthetic agents, blood pressure is lowered during the course of the anesthesia In the case of the young patients of the 3, 4 or 5 year age groups the complacency of the parent is a factor in the successful handling of the patients, and to most mothers it is comforting to see her child leave the hospital room sleeping quietly, the amnesia is likewise a welcome feature of this method

The advantages of tribromoethanol-ether anesthesia compared with local anesthesia when employed for tonsillectomy may be enumerated There is no apprehension on the part of the patient This method can be used in all age groups, whereas local anesthesia is of use only in patients over 15 years of age With this type of general anesthesia it is quite simple to do a complete adenoidectomy, whereas there has never been a completely successful method of performing adenoidectomy with a patient under local anesthesia Control of bleeding is easily and simply carried out in both the tonsillar and the adenoidal areas The placement of sutures is considerably easier than under local anesthesia A wider choice of operative procedures is possible There is no necessity to use opiates preoperatively

In this entire series of cases there has been no mortality either from the anesthetic or from the operation There has also been no increased morbidity which could be ascribed to the anesthetic agents employed Postoperative nausea and vomiting have been distinctly less than where other means of producing general anesthesia have been used, such as ether without the preceding basal anesthetic A much shorter time is needed to bring the patient to the state of surgical anesthesia when tribromoethanol is used We have noted no tendency in patients of the various age groups to become cyanotic, and it has not been necessary to employ any measures of resuscitation There have been no cases in which the operation had to be discontinued because of anesthetic difficulties

During the stage of ether induction of surgical anesthesia some patients have to be restrained for a short time, and in a few instances children need to be restrained while they are recovering from the anesthetic

Tribromoethanol is a white crystalline substance which is soluble in water at 104 F up to 35 per cent It is supplied in a concentrated solution with amylene hydrate, each 1 cc containing 1 Gm of tribromoethanol and 0.5 Gm of amylene hydrate In the usual dosage it is administered as a 2.5 per cent aqueous solution of tribromoethanol solution U S P

In this series of cases it has been our policy to use the anesthesia obtained with tribromoethanol U S P as a true basal anesthesia The dosage employed is 80 mg

of tribromoethanol (40 mg of amylene hydrate) per kilogram of body weight. The dosage has varied only in the case of obese patients with whom we often use but 70 mg per kilogram. We have never attempted to carry out the operation with the use of tribromoethanol solution U S P alone. The U S P solution is thoroughly mixed with distilled water of a temperature between 102 and 104 F. The diluted solution is then tested for stability by adding 1 drop of 1/1000 aqueous congo red solution to a tube containing 5 cc of the water-tribromoethanol solution. A pure orange red color is the normal result. If the color becomes blue or violet, the solution should be discarded, as this indicates that the tribromoethanol solution has become decomposed and is dangerous to use. If stable, the prepared solution is given by rectum from twenty to thirty minutes before the patient is scheduled to be in the operating room. The great majority of patients are asleep within ten minutes from the time of administration, and a few within five minutes. In instances in which there has been some delay in the operating room, patients have had the solution as much as an hour prior to the operation and during that time they have remained asleep.

After operation most patients have recovered from the anesthetic and are awake within a thirty or forty-five minute period, many will be quite drowsy

TABLE 2—*Data on a Representative Group of Patients*

Age range	4 to 61 yr
Amount of tribromoethanol solution U S P used	18 to 55 cc
Time from use of anesthetic until patient was asleep	4 min 30 sec to 20 min
Duration of operation	5 to 25 min
Amount of ether used	15 to 75 cc
Number of patients with cyanosis	None
Number with respiratory depression	None
Number with vomiting	7

and may sleep, after first awakening, for two or three hours. With the dosage of tribromoethanol used in this series we did not have any patients so completely relaxed that a breathing tube, or "airway," was needed. As a routine, the patient is kept on his side until after he has reacted from the anesthetic, this allows more freedom of breathing, since any blood and oral secretions will then run out of the mouth instead of being swallowed or aspirated. There have been no cases of postoperative pulmonary complications, either immediate or remote. Many of the children when operated on had a profuse amount of postnasal mucus, but this has led to no complications other than a continued cough for a short time postoperatively. The source of this excessive mucus has almost always been hypertrophic adenoiditis. We have made it a practice not to operate on any patient whose oral temperature is over 99 F.

The amount of ether necessary for completion of the operation varies with the age and the weight of the patient. In the instance of the youngest patient of this series, a 5 month old girl on whom adenoidectomy was performed, only 15 cc of ether was required. In large, robust adults as much as 120 cc has been required, though the latter amount is the exception.

Table 2 represents a one month summation of the data on which this paper is based. The table considers the 96 patients operated on during the month of July 1946. The patients listed in this month are representative of the entire 3,042 of the series.

Table 3 indicates the average amount of ether administered to children of the 0 to 10 year group for adenoidectomy alone (72 cases)

Table 4 indicates the average amount of ether administered to children of the 0 to 10 year group for tonsillectomy and adenoidectomy (1318 cases)

No control series has been evaluated, but it is our distinct feeling that considerably less ether is needed for completion of the operation when ether anesthesia is combined with tribromoethanol anesthesia than when ether anesthesia alone is used. The time of induction is considerably less when ether anesthesia is combined with tribromoethanol anesthesia than when ether anesthesia alone is used. The average time elapsed from the start of the ether portion of the anesthetization until the operation is begun is four minutes and twenty seconds, and this represents the time for both children and adults

TABLE 3—*Average Amounts of Ether Required for Adenoidectomy in Children in Whom Basal Anesthesia Had Been Produced with Tribromoethanol Solution U S P*

Age Group	Av Amt of Ether, Cc	Age Group	Av Amt of Ether, Cc
0 to 1 yr	15	5 to 6 yr	23
1 to 2 yr	21	6 to 7 yr	28
2 to 3 yr	25	7 to 8 yr	30
3 to 4 yr	25	8 to 9 yr	30
4 to 5 yr	27	9 to 10 yr	32

TABLE 4—*Average Amounts of Ether Required for Tonsillectomy-Adenoidectomy in Children in Whom Basal Anesthesia Had Been Produced with Tribromoethanol Solution U S P*

Age Group	Av Amt of Ether, Cc	Age Group	Av Amt of Ether, Cc
0 to 1 yr	(None operated on)	5 to 6 yr	35
1 to 2 yr	22	6 to 7 yr	35
2 to 3 yr	26	7 to 8 yr	40
3 to 4 yr	28	8 to 9 yr	40
4 to 5 yr	32	9 to 10 yr	45

Patients who are to undergo adenoidectomy or tonsillectomy-adenoidectomy are given a cleansing enema the evening before operation, and all are operated on early in the morning. No sedatives are used preoperatively. Postoperatively children are given codeine as required, while adults are given pantopon® (a mixture of the hydrochlorides of the opium alkaloids) as required. All patients are hospitalized for twenty-four hours after operation.

Contraindications to the use of tribromoethanol anesthesia as a basal anesthesia include dysfunction of liver or kidneys, severe cardiac disease, old age, shock or dehydration, sepsis, toxemia, severe pulmonary tuberculosis, empyema, hyperthyroidism, obesity, asthenia, cachexia, ileus, tumors of the colon, enteritis and acidosis. We feel that morphine sulfate should not be administered before tribromoethanol anesthesia as it may enhance respiratory depression.

One case of allergy to tribromoethanol has been encountered. A 6 year old boy, with no previous history of allergy, had generalized urticaria fifteen minutes after the administration of tribromoethanol. On his awakening, pruritus was severe, but a single dose of epinephrine hydrochloride given subcutaneously quickly relieved his symptoms. There has been no recurrence of the urticaria in the seven months since operation.

SUMMARY

An analysis of 3,042 cases in which tribromoethanol solution U S P was used to produce a basal anesthesia for the removal of the adenoid or the tonsils and adenoid is given. In all of these cases tribromoethanol-ether anesthesia was administered. The advantages of this type of general anesthesia over local anesthesia and other types of general anesthesia are shown. The anesthetic results have been uniformly good, and there have been no anesthetic deaths or emergencies in this series. The judicious use of a relatively low dosage of tribromoethanol makes this a safe, dependable procedure.

727 First National Bank Building

USE OF THIOPENTAL SODIUM U S P (SODIUM PENTOTHAL®) IN OPERATIONS ON EAR, NOSE AND THROAT

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DURING the past five years we have used thiopental sodium U S P (pentothal sodium®) in 1,636 operations on the ear, nose and throat. The unwarranted criticism of this anesthetic agent in otolaryngologic operations has prompted us to describe our experiences with this particular anesthetic.

It is not our intent that thiopental sodium should replace all other anesthetics for operations on the ear, nose and throat, but we do maintain that it is highly satisfactory in those cases in which it is definitely not contraindicated, as determined by history, physical examination and laboratory findings. The ease with which it is administered, the rapidity of its action, as contrasted with that of inhalation anesthetics, the absence of postanesthetic nausea and vomiting and the rapid recovery to the conscious state have a strong appeal to both surgeon and patient. It seems that the chief objection to its use in throat surgery is that so-called laryngospasm is frequently encountered, and if it is not overcome at once respiratory and cardiac embarrassment will result. We do not believe this to be true in anything like the high percentage of cases indicated by some authors. We do know that thiopental sodium is a powerful respiratory depressant and have come to realize that there is a definitely narrow margin between the abolition of cough and gag reflexes and depression of the respiratory center. This fact was so strikingly impressed on one of us (G E F) in one of the first cases in which we used this anesthetic that we hesitated to use it again for a considerable time. The patient was a white man with carcinoma of the larynx, who had a short, fat neck, excellent teeth and an extremely sensitive gag reflex. These factors made it practically impossible for us to perform laryngoscopy on him with use of local anesthesia, and thiopental sodium was chosen as the anesthetic agent. To abolish the cough and gag reflex, a large amount of this drug, had to be administered, and the patient ceased breathing for several minutes, even

though the larynx and lower air passages were completely open and free from obstruction with the laryngoscope within the larynx. The laryngoscope was attached to an oxygen bag and respiration reestablished. The answer to this problem led us to use a local anesthetic for the pharynx and larynx ten minutes prior to the injection of thiopental sodium. We have never had a repetition of this experience since we began to use the local anesthetic prior to the injection of thiopental sodium.

We present herewith our methods of administration of thiopental sodium in surgical procedures on the ear, nose and throat.

TONSILLECTOMY AND ADENOIDECTOMY

When we contemplate the use of thiopental sodium for a tonsillectomy in an adult, 100 mg of meperidine hydrochloride (demerol hydrochloride®), $\frac{1}{3}$ grain of pantopon® (a mixture of the hydrochlorides of the opium alkaloids) or 2 grains (0.12 Gm) of amobarbital sodium (amytal sodium®), as desired, may be given hypodermically, along with $\frac{1}{150}$ grain (0.4 mg) of atropine sulfate, one hour before the time planned for operation. These preoperative agents control parasympathetic hyperactivity and inhibit excessive salivary and mucous secretions, thereby reducing cough and constant swallowing. When the patient is brought to the operating room, the nose is lightly sprayed with 1 per cent cocaine solution and the throat thoroughly sprayed with 2 per cent tetracaine hydrochloride (pontocaine hydrochloride®). Approximately ten minutes is allowed to elapse before thiopental sodium is administered intravenously. The dose cannot be calculated according to the patient's weight, age or metabolic state but is adjusted entirely to his individual need. When the intravenous anesthetic has produced the necessary relaxation, without respiratory embarrassment, the operation can begin. Oxygen is administered either by nasal tube or directly into the open mouth by means of a "hook" when operations on the throat are performed. The intravenous anesthetic is administered very slowly and is not increased after a proper stage of anesthesia is obtained unless indicated by movement of the patient. We always endeavor to have the patient practically awake before leaving the operating room, as any abnormal secretions reaching the larynx immediately after the operation may produce rather violent paroxysms of coughing.

We are especially careful during the course of the operation that no blood be allowed to accumulate in the hypopharynx or laryngeal orifice. If this occurs, the patient is apt to cough considerably. This complication can be avoided by elevating the foot of the table several inches above the head so that secretions will not gravitate to the hypopharynx. Extreme care must be given to this detail, and the hypo-

pharynx must be constantly observed by the person using the suction apparatus

When bleeding points in the tonsillar fossae and nasopharynx have been completely controlled, the mouth gag is removed and an airway inserted. This is left in place until rejected by the patient.

INTRANASAL OPERATIONS

For intranasal operation the same premedication is used. The nose, nasopharynx and throat are prepared with a local anesthetic as for tonsillectomy and adenoidectomy. As soon as the patient has been anesthetized with thiopental sodium, a pack is placed in the nasopharynx to keep blood from entering the pharynx. An airway is then inserted to assure a perfectly clear air passage.

The nasal mucosa is then carefully anesthetized by 10 per cent cocaine solution applied with cotton-tipped applicators. When the operation has been completed and bleeding controlled as completely as possible, the nose is packed in the following manner. A sterile rubber finger cot is inserted into the nose from the vestibule to the sphenoid region, and $\frac{1}{2}$ inch (1 cm) of plain gauze is packed snugly within the cot until the desired pressure is obtained. The airway is then removed, a Davis-Crowe mouth gag inserted, the nasopharyngeal pack removed and the pharynx thoroughly suctioned. The airway is then reinserted and left in place until rejected by the patient.

MASTOID OPERATION

Prior to operations on the mastoid process, the throat is sprayed with 2 per cent tetracaine hydrochloride solution. Thiopental sodium is given in the usual manner and an airway introduced by the anesthetist before the operative site is prepared and draped.

Endoscopy—We use a local anesthetic for practically all laryngoscopic, bronchoscopic and esophagoscopy procedures. However, when a very apprehensive, uncooperative patient is encountered, thiopental sodium may have to be used in order to carry out a satisfactory examination. In such cases we prepare the patient in exactly the same manner as if the operation were to be performed with use of a local anesthetic, by thoroughly cocainizing the larynx, trachea and bronchi, prior to administration of thiopental sodium.

Laryngectomy and Laryngofissure—Our technic in handling anesthesia for laryngectomy is to give the usual preoperative medicaments one hour before operation. When the patient is brought to the operating room, we first anesthetize the larynx and trachea with 2 per cent tetracaine hydrochloride and 4 per cent cocaine, as thoroughly as if a bronchoscopic examination under a local anesthetic were to be per-

formed. The operative site is then thoroughly cleansed and prepared in the usual manner. A midline incision is made and the soft tissue dissected under local anesthesia. When the larynx and trachea have been skeletonized, the head of the table is lowered about 20 degrees and a tracheotomy is performed. The patient is then given thiopental

Operative Procedures Used by Authors

Procedure	No. of Cases
Tonsillectomy and adenoidectomy	738
Curettement of nasopharynx	112
Removal of nasopharyngeal tumor	9
Mastoidectomy (simple and radical)	80
Intranasal operations	
Submucous resection of nasal septum	229
Ethmoidectomy and/or sphenoidectomy and nasal polypectomy	147
Turbinatectomy for hyperplastic rhinitis	33
Formation of nasoastral window	51
Ethmoidectomy and formation of nasoastral window	6
Formation of bilateral nasoastral window and adenoidectomy	1
Submucous resection and formation of nasoastral window	1
Submucous resection and ethmoidectomy	2
Submucous resection and adenoidectomy	13
Ethmoidectomy and adenoidectomy	1
Removal of intranasal tumor	12
Caldwell Luc operation	28
Removal of tumor of maxillary sinus	5
Trephination of frontal sinus	7
Radical operation on frontal sinus	9
Repair of fractured nose	12
Packing of nasopharynx and nose	3
Removal of elongated styloid process	1
Biopsy of tongue, soft palate, submaxillary glands, tumor in neck	13
Removal of calculus of submaxillary duct	7
Removal of sublingual gland	1
Removal of cyst of epiglottis	2
Incision and drainage of abscesses of ear, nose and throat	11
Suturing for postoperative hemorrhage in tonsillectomy and adenoidectomy	2
Nasopharyngoscopic examination, myringotomy and/or inflation of eustachian tubes	3
Endoscopy *	
Bronchoscopy	13
Laryngoscopy	11
Esophagoscopy	17
Laryngofissure	22
Laryngectomy	28
Biopsy of hypopharyngeal tumor	6

* In contrast, 2,699 endoscopic operations were performed with use of a local anesthetic during the same period.

sodium, and the trachea and larynx above the tracheotomy tube are packed lightly with ribbon gauze so that no blood or secretions from above will pass down the trachea, past the tube and into the lung. The larynx and epiglottis are then removed and the defect closed.

When laryngofissure is to be done, the patient's larynx and trachea are cocaineized in the manner described, and all dissection of soft tissue

done with the use of a local anesthetic. The patient is given thiopental sodium from the time the larynx is opened until the operation has been completed.

The table indicates the different operative procedures carried out on our patients.

We do not use thiopental sodium in operations on the ear, nose and throat of children under 15 years of age unless the child is unusually large for his age. For younger children we use ether exclusively.

A total of 717 operations were performed from Sept. 1, 1943, until May 1, 1948, at St. Vincent's Hospital by one of us (G. E. F.), 889 operations were performed from Jan. 1, 1943 to June 15, 1948 by us at the Jefferson-Hillman Hospital of the Medical College of Alabama. No death from anesthesia occurred in this series of 1,636 operations with thiopental sodium as the anesthetic.

RADIUM AND THE LYMPHOID TISSUE OF THE NASOPHARYNX AND PHARYNX

A New Universal Applicator

WALLACE MORRISON, M D

NEW YORK

IN THE brief discussion that follows I propose to limit my remarks to the practice of using the ionizing radiation of radium in the nasopharynx and pharynx for the reduction of lymphoid tissue causing definite symptoms. The difficulties of the complete surgical removal of such tissue make such radiation not only the most convenient but the most efficient means of treatment.

IONIZING RADIATION

Radium and its emanation, radon, have exactly the same characteristics in that they constantly emit three types of radiation. 1 Alpha rays, which are positively charged helium nuclei, since these cannot pass through the wall of the Monel metal capsule used in treatment, they require no further consideration. 2 Beta rays, comprising about 80 per cent of the radiation, which are negatively charged electrons of varying high speeds up to that of light, their chief characteristic is their comparatively mild ability to penetrate living tissue, it is estimated that 93 per cent are absorbed and exert their effects in the first centimeter of tissue. 3 Gamma rays, forming about 20 per cent of the radiation, which are composed of electrons having no electric charge, moving with the speed of light and having a very short wavelength, they are exceedingly penetrative, some passing through 12 inches (30.5 cm) of solid lead, when they are stopped in the tissues they scatter electrons which act like the beta rays and thus ionize tissue cells.

For comparison, one may note that the modern x-ray tube emits (1) cathode rays which are essentially the same in physical characteristics and biologic effects as the beta rays of radium and (2) gamma rays which are exactly similar to those of radium. Thus it is readily understood that the roentgen rays of the x-ray tube and the beta and gamma rays of radium and radon produce exactly the same effects in living tissues. The rays are absorbed by tissue cells, and the energy thus

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released ionizes the living cells and causes their gradual death. Tissues vary greatly in their sensitivity to such radiation, it is fortunate that the small round lymphoid cell which is the chief component of adenoid tissue is fairly radiosensitive, especially when it is newly formed in a germinal center of lymphoid tissue. It is on this greater sensitivity of the lymphoid cells as compared with the epithelial and connective tissue cells also present that radiation therapy is based. The total effect of properly administered radiation is a slow reduction in the size of smaller masses of lymphoid tissue, so that they flatten and become much thinner, and any folds, pits or crevices in the tissue are widely opened or completely obliterated.

THE STANDARD RADIUM APPLICATOR

The present day method of using radium in the nasopharynx includes the employment of the Monel metal capsule, which is 25 mm long, with walls 0.3 mm thick, and which contains in its 15 mm center section 50 mg of pure radium sulfate. This capsule is brazed to a stiff brass rod and has a small handle. It is passed along the floor of the nose until the capsule is in the nasopharynx in close contact with the opening of the eustachian tube and the area just posterior to this opening. The radiation is essentially beta radiation of comparatively low penetration. The action is directly on adjacent lymphoid tissue without the interposition of any tissue except the overlying epithelium. It is this directness of application and action which constitutes the great advantage of radium irradiation over roentgen irradiation of the lymphoid tissue of the nasopharynx and pharynx. Since the roentgen rays must be applied from outside the head, much normal tissue is exposed to the rays as they pass, before the lymphoid tissue is reached, and the overlying skin is most heavily acted on by the radiation. Radium applied in the nasopharynx would seem far preferable, as more effective, more readily controlled and with no greater danger than external roentgen radiation.

RADIUM DOSAGE IN THE NASOPHARYNX

Accurate measurements of the radiation from the Monel metal capsule are not easy to make. Measurements of the surface action based on the fogging of photographic film are reasonably accurate, but the dosage reaching the depths of living tissue can only be estimated mathematically. Schulz and Robbins¹ stated that the standard applicator yields about 150 roentgens (r) per minute at the tissue surface. This is reduced to about 47 r per minute at a depth of 2 mm and to only 10.5 r per minute 5 mm below the surface. This amounts to about 1,800 r to the surface tissues in close contact with the center area of the

¹ Schulz, M. D., and Robbins, L. L. *Tr Am Acad Ophth* 53 243, 1949

applicator in the usual twelve minute treatment. This dose approximates 800 r 1 mm below the surface. This is greater than the usual dose of roentgen rays when they are given in the amount of 125 r to each of two skin areas on each side of the head, and the administration repeated in one week, approximating in all about 1,000 r. It is thus evident that in using the radium capsule one is applying a fairly heavy dose to the surface tissues.

Crowe and others have estimated that with the 50 mg applicator the maximum standard dose is attained in twelve minutes. A great number of clinical tests with this dose reveal that it is well below the erythema dose in the nasopharynx. Such a dose may be safely repeated after an interval of two weeks if no clinical reaction follows the first treatment. Three or four such treatments may be given in one series, at the same interval of two weeks. No further doses should be given for at least six months, and then only after careful determination that there is a real need for further treatment.

THE USES OF RADIUM IN THE NASOPHARYNX

Radium irradiation of the lymphoid tissue of the nasopharynx is used for 1 Recurrent aero-otitis media. Thousands of adults were treated by this method in the armed services in the last war². The results were almost uniformly successful in preventing further attacks and similar effects have been reported quite widely on a much smaller scale in civilian practice.

2 Recurrent acute catarrhal otitis media in children after adenoidectomy, and in adults with visible lymphoid tissue in the nasopharynx near the eustachian tube. The reduction of the lymphoid tissue lessens the likelihood that further attacks of acute otitis will occur whenever the nasopharynx becomes inflamed.

3 Mild high tone deafness in children who have visible but small amounts of lymphoid tissue in the nasopharynx about the eustachian tube after adenoidectomy. Crowe and others³ have noted quite satisfactory results.

4 Prevention of recurrent secondary bacterial infections of the middle ears and paranasal sinuses following virus infection of the upper respiratory tract in children with nasopharyngeal lymphoid tissue after adenoidectomy. The radiation reduces the size and thickness of the lymphoid tissue and thus opens the folds, pits or actual crypts in the tissue, in which it seems probable that bacterial secondary invaders are harbored. Crowe and others³ have been doing this sort of preven-

2 Aero-Otitis Control Program of Army Air Forces Report, Ann Otol, Rhin & Laryng 54 649, 1945

3 Crowe, S J, and others Bull Johns Hopkins Hosp 83 383, 1948

tive treatment for more than twenty years, and their reports in the main are quite favorable. Whether such radium treatment may also be helpful in some adults with definitely visible, irregular lymphoid tissue, who suffer the same type of recurrent acute bacterial infection of the middle ears or sinuses as complications of virus invasions is a problem that is now being investigated. It will be a considerable period before results can be fully measured.

5 Prevention of recurrent acute exacerbation due to infection ascending through the eustachian tube from visible lymphoid tissue in the nasopharynx in chronic purulent otitis media with central perforation of the tympanic membrane, by reducing the source of the acute infection in the nasopharynx. The same method may be of practical use in cases of marginal perforation of the tympanic membrane with possible cholesteatoma, if surgical treatment of these dangerous infections of the middle ear is refused.

THE USE OF RADIUM IN THE PHARYNX

Radium irradiation of the pharynx is proposed for the reduction of hypertrophy with the consequent chronic infection of the lateral pharyngeal bands and pharyngeal lymphoid follicles, which harbor bacteria within their pits and folds. These structures often enlarge after tonsillectomy and adenoidectomy in children and are common in adults who have undergone tonsillectomy or in those who have recurrent acute sore throat or chronic pharyngeal inflammation centering about these lymphoid bands and patches, when the tonsils are not involved as a cause. Up to the present time I have not been aware of any suitable applicator for such treatment, the flexible applicator to be presented will make this type of therapy most easy.

CONTRAINDICATIONS TO THE USE OF RADIUM

Radium should not be used in the nasopharynx for (1) deafness in children when there is a marked high tone loss, especially when the bone conduction loss determined from the audiogram is at or greater than 30 decibels for the same high tones, such children have a true nerve deafness and will almost certainly not be benefited by radium, (2) nerve deafness in adults, (3) otosclerosis, (4) chronic purulent otitis media without acute exacerbations or in those who have minimal nasopharyngeal lymphoid tissue, (5) any condition in which there is any trace of atrophy of the mucosa of the nasal cavities, the nasopharynx or the pharynx, (6) such localized lesions as congenital pits, bursas and cysts in the adult nasopharynx, other treatment is essential in such conditions.

Relative contraindications to the use of radium are (1) recent acute infection of the upper respiratory tract, (2) recent acute otitis media or

acute exacerbation of chronic purulent otitis, (3) presence of large masses of lymphoid tissue in the nasopharynx—such tissue must first be reduced as much as possible by appropriate surgical removal, beta radiation can produce satisfactory effects only when applied to comparatively thin lymphoid tissue, because of the low penetrating power, (4) recent radium or roentgen irradiation of the head or of the nasopharynx

THE ABUSE OF RADIUM THERAPY

It should be clear that the proper use of this powerful agent rests squarely on an accurate diagnosis in which one has determined that the visible lymphoid tissue is present in small to moderate amounts only. Such a diagnosis calls for skilful use of the postnasal mirror or the electric nasopharyngoscope or both. Any one without the necessary training, skill and experience to make such an accurate diagnosis should not be using radium in the nasopharynx. When radium is used for conditions in the ear, it is further necessary to determine first the exact nature of the aural changes and to interpret any loss of hearing shown in the audiogram, any one who cannot properly do this should not be using radium.

It would seem proper in the light of this hinging of the use of radium on a careful and accurate diagnosis that radium applicators should be in the possession only of qualified otolaryngologists and that their issuance to others should not be allowed. Even when the diagnosis has been made by an otolaryngologist, he must most carefully supervise radium treatment given under his direction by an assistant or a nurse.

The indiscriminate use of radium is to be condemned, especially if the patients are adults, or if it is a mere routine after adenoidectomy in children. Radium is being used by some without an accurate diagnosis for such vague purposes as to "prevent colds," to "cure" what Proetz has called the great American nightmare, postnasal drip, and for tinnitus and deafness which are clearly due to disturbances of the internal ear or to otosclerosis, and even routinely whenever there is a little patch or two of atrophic lymphoid tissue somewhere in the nasopharynx. Radium is a powerful agent, to be most carefully used, since its potential dangers are not yet fully known.

THE DANGERS IN THE USE OF RADIUM

The dangers in the use of the Monel metal applicator are those involving, first, the operator, such as

- 1 The incomprehensible accident of carrying the bare applicator in the pocket, with burning of the skin

- 2 The insidious damage done to the fingers by repeated small doses, which can lead to atrophy of the skin and nails and possibly much later

to ulceration and epithelioma. The applicator is said by Schulz and Robbins¹ to have an ionizing radiation of 10 r per hour at the end of the handle, while half way down this dose is quadrupled. The applicator when out of its lead safe must always be handled with dispatch, and the capsule never touched with the fingers. A long-handled brush must be used to cleanse the applicator after use. If many treatments are being given the wearing of lead rubber x-ray gloves is advisable.

3 Damaging of the hemopoietic system with production of anemia and leukopenia by long-continued exposure to very small amounts of the gamma radiation. Schulz and Robbins¹ stated that a total body irradiation of only 0.1 r per day is now considered to be the tolerance level for the blood-forming organs. The 50 mg applicator requires 2 cm of lead to reduce the gamma radiation to this level at a distance of 1 meter, and 7 cm of lead at 0.5 meter. The applicator must always be stored in its carefully closed lead safe 20 feet (6 meters) or more from any one such as secretary, nurse or doctor who may be exposed through the usual eight hour day. The operator should retire from the treatment room during the time the applicator is in the nasopharynx, although some means of quick recall must be provided when necessary. The mother or other relative should stand by the child during treatment for reassurance and control, rather than the operator.

4 Since the gonads are highly sensitive to ionizing radiation, it is usually advisable when many treatments are being given for the operator to wear a lead rubber apron as in fluoroscopy. At all times it must be remembered that distance is the best protection against damage due to repeated, though small, exposures.

Dangers to the patient are: 1 An acute overdose with local erythema, edema or blistering. This must always be prevented by the most careful timing of each dose and by maintaining close control of the patient during the treatment. 2 Late effects such as atrophy of the mucosa, telangiectasis, ulceration and perhaps even cancer. These should never occur if the doses given are always well below possible erythema levels and the method is not abused by giving more than three or four treatments in any one series, by failing to see that they are carefully spaced, and by administering more than one such series in six to twelve months.

A NEW UNIVERSAL NASOPHARYNGEAL AND PHARYNGEAL RADIUM APPLICATOR

I wish to present a new type of flexible radium applicator. It is of the same general measurements as the standard rigid applicator except that the cannula has a little greater diameter (fig 1), it will nevertheless slip through all but very badly obstructed nasal chambers. It consists of a rigid, straight cannula having a conical handle with an

indicating ring. The terminal 7.5 cm. of the operative end is made of a flat flexible spiral spring, into the free end of which the standard 25 mm. Monel metal radium capsule is firmly fixed. A heavy straight wire stylet is provided.

When the wire stylet is in place within the cannula, the applicator is straight and rigid and can be used in the way in which the present standard applicator is employed (fig. 2 *A*). This will adequately reach lymphoid tissue in and immediately about the orifice of the eustachian tube and the area just posterior to the orifice. When there is lymphoid tissue above and behind (fig. 2 *B*) or below and behind the orifice (fig. 2 *C*), the withdrawal of a part of the wire stylet allows the natural curve of the spiral spring of the universal applicator to bring the radium capsule into really close contact with such tissue. Since close contact is required for the full ionizing effect of any calculated dose of radiation

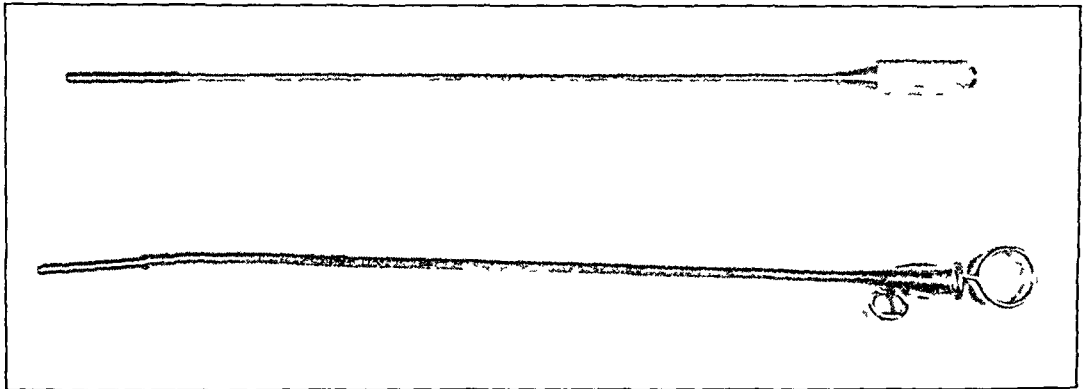


Fig. 1—The standard and the new universal nasopharyngeal radium applicator. The standard applicator (upper one) is a rigid instrument. The new applicator (lower one) is a flexible applicator, shown with its wire stylet in situ.

the flexible applicator offers advantages that are impossible with the rigid applicator. The manufacturers of the standard applicator strongly advise against bending the brass rod in endeavors to more nearly reach areas other than the mouth of the eustachian tube, for fear that the radium capsule may be opened by so doing and the radium scattered. The flexible applicator enables one to reach any lymphoid tissue in the nasopharynx without making such precaution necessary.

A further great advantage of the flexible applicator is that it allows for the first time accurate and comfortable irradiation of the lateral pharyngeal bands and pharyngeal follicles. Under mild local anesthesia of the floor of the nose and the side of the pharynx, the applicator with its stylet in situ is passed into the nasopharynx through the nose, with the indicating ring turned down (fig. 3). Withdrawal of the stylet completely out of the flexible portion allows this portion to turn through

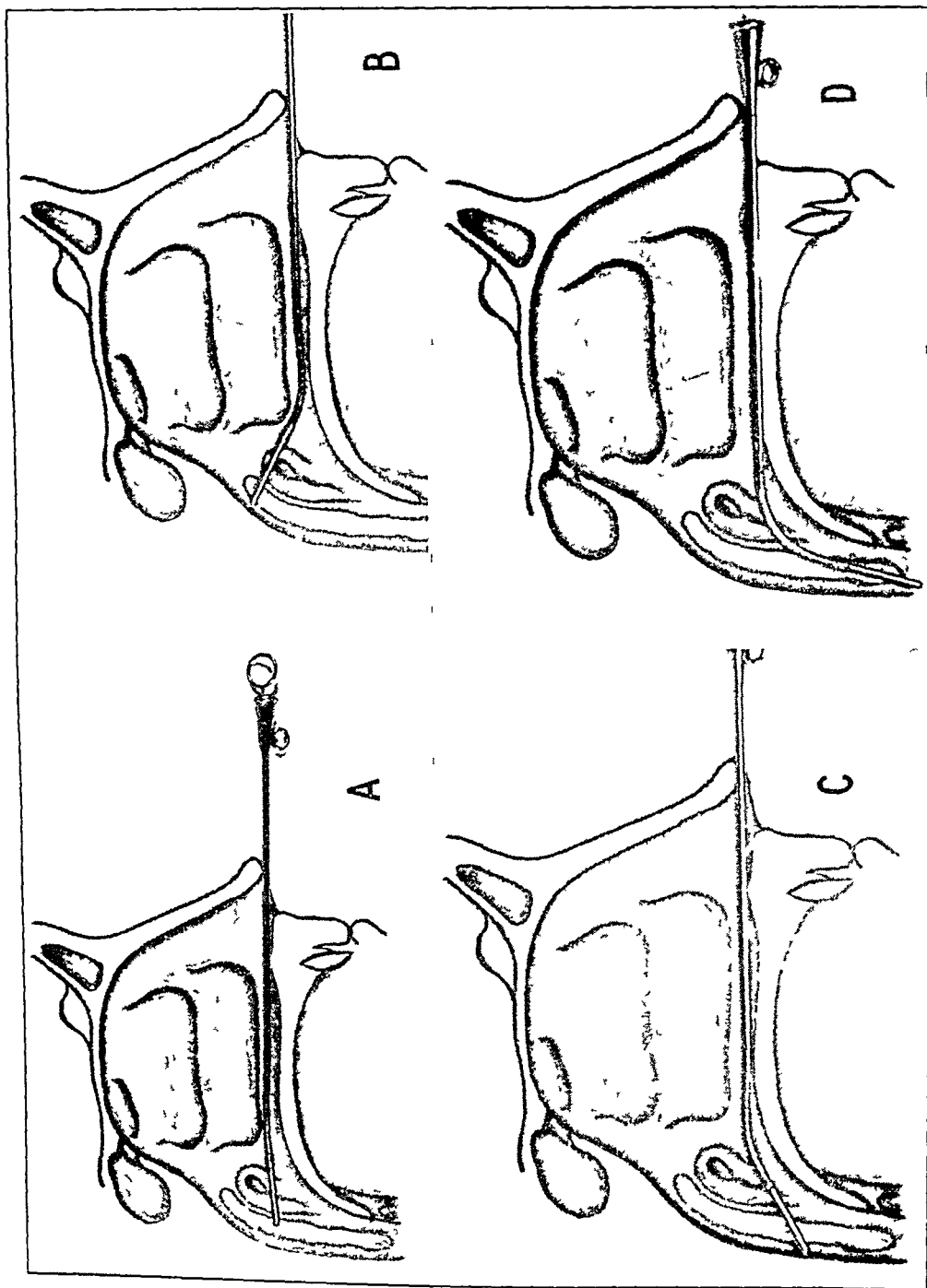


Fig 2—The new universal applicator in use A, for lymphoid tissue that is in or just posterior to the orifice of the eustachian tube B, for lymphoid tissue that is above and behind the orifice, in Rosemüller's fossa C, for lymphoid tissue that is below and behind the orifice D, for the lower portion of the lateral pharyngeal band

a right angle, so that it lies with the radium capsule in close contact with the lateral band throughout most of its length

At present an initial treatment of six minutes is given on each side. Later, treatments of eight minutes are given at intervals of two weeks if there has been no visible reaction or soreness after the first irradiation of the tissue. From three to five such treatments are given, the number will depend on the thickness and the width of the lateral bands and on the effect of previous treatments.

The method offers gradual reduction of the size of these structures by a technic that is easy and comfortable for the patient. The action is so much more direct and controllable than that of external roentgen radiation that it seems greatly preferable. While the lateral bands and pharyngeal follicles should always be punched or dissected off during adenoidectomy in children, this operation has never been widely accepted for adults. This is probably because of the demand made on the cooperation of the patient if the operation is done under local anesthesia, and a natural reluctance to use general anesthesia for such a comparatively minor procedure. The pharyngeal bands and patches can also be removed by piecemeal electrocoagulation, but time has shown that the process is slow, recurrently painful and often marked by repeated secondary bleeding.

SUMMARY

The rationale, the technic, the purposes and the contraindications, the abuses and the dangers of the nasopharyngeal employment of the standard Monel metal radium applicator are briefly discussed.

A new type of flexible applicator is presented by which practically any area of the nasopharynx can be easily reached for accurate dosage, and which can also be used to apply radiation to the lateral pharyngeal lymphoid bands and patches with accuracy and ease.

140 East Fifty-Fourth Street

NOTE—The metal cannula for the universal applicator is made by G. S. Pilling & Sons, of Philadelphia. The radium capsule is supplied and attached by the Radium Chemical Company, of New York. Mr. George Loftus, of the Radium Chemical Company, helped in the development of the new applicator.

PRIMARY AMYLOID DEPOSITS IN THE LARYNX

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PRIMARY nodular amyloid deposits in the laryngeal mucosa is an infrequently reported lesion. A perusal of the *Quarterly Cumulative Index Medicus* of the past twenty-five years reveals only 15 reports of this lesion, and, of these, only 4 cases are in the English literature. Beavis¹ in 1934 reported on 5 cases, the largest series in the English language. This author stated the opinion that local amyloid deposits in the upper respiratory passages are rare, since there were no more than 50 cases in the entire literature. It was considered that the disease would be more readily recognized in the future, however, the number of recorded cases since that time has remained small. In a review of fundamental disorders of the larynx, Kernan² did not mention amyloid deposits. Standard textbooks of pathology give scant, if any, mention of this condition. Because of this paucity of reports, we wish to record 5 additional cases in which the diagnosis resulted from the microscopic examination of the lesions.

Classifications of amyloid deposits usually distinguished secondary amyloidosis, primary amyloid deposits (local and diffuse or systemic types) and amyloid deposition associated with multiple myeloma.³ Lubarsch's criteria⁴ for primary amyloid infiltration are usually applied and include the exemption of organs ordinarily involved in secondary amyloidosis, a tendency to nodular accumulation, atypical reactions to

From Surgical Pathology Department, Baylor University Hospital

1 Beavis, J O Local Amyloid Disease of the Upper Air Passages Report of Five Cases, Arch Otolaryng 19 439-450 (April) 1934

2 Kernan, J D Fundamental Pathology of the Larynx, Laryngoscope 47 77-91, 1937

3 (a) Koletsky, S, and Stecher, R M Primary Systemic Amyloidosis Involvement of Cardiac Valves, Joints and Bones, with Pathologic Fracture of the Femur, Arch Path 27 267-288, 1939 (b) Eisen, H N Primary Systemic Amyloidosis, Am J Med 1 105-212, 1946 (c) Lindsay, S The Heart in Primary Systemic Amyloidosis, Am Heart J 32 419-437, 1946

4 Lubarsch, O, cited by Kramer and Som¹³

the usual amyloid stains and the absence of a demonstrable underlying cause. Secondary amyloidosis has been considered to be a fairly common condition.⁵ According to Lindsay,^{3c} Eisen^{3b} and Iverson and Morrison,⁶ less than 50 cases of primary systemic amyloidosis had been reported up to the period covered by this study (1946-1948). Atkinson⁷ demonstrated the presence of amyloidosis in 40 of 643 cases of multiple myeloma. Brunsting and MacDonald⁸ presented 4 additional cases and implied a similarity between Bence Jones protein and amyloid. Kolff and Dhont⁹ discussed theoretic considerations concerned with the relation of plasma cells to amyloid deposits. The frequency of primary amyloid deposits in the upper air passages is referred to later. Primary idiopathic amyloid deposits have also been observed to be confined at times to other areas of the body. Thus,⁷ cases of primary amyloid tumors of the urinary bladder have been reported, according to Purcell and Brown.¹⁰ Isolated amyloid deposits in the skin were demonstrated by postmortem study in Greenbaum and Bauer's case.¹¹ The cause of amyloid accumulation remains obscure. The deposition occurs mainly in relation to smooth muscle fibers and connective tissue of the blood vessels and their immediate environs. Several workers have mentioned the possible role of hypersensitivity¹² as a background for primary amyloid deposition.

Kramer and Som¹³ differentiated four groups of tumor-like deposits of amyloid in the upper air passages: local deposits secondarily within neoplasms or areas of chronic inflammation, local deposits that constri-

5 Selikoff, I. J. Diagnosis of Generalized Amyloidosis by the Congo Red Test. Definite Diagnostic Criteria, *Am J M Sc* **213** 719-727, 1947.

6 Iverson, L., and Morrison, A. B. Primary Systemic Amyloidosis, *Arch Path* **45** 1-20 (Jan) 1948.

7 Atkinson, F. R. B. Multiple Myelomata, *M Press* **195** 312, 1937.

8 Brunsting, L. A., and MacDonald, I. D. Primary Systematized Amyloidosis with Macroglossia. A Syndrome Related to Bence Jones Proteinuria and Myeloma, *Proc Staff Meet, Mayo Clin* **22** 67-70, 1947.

9 Kolff, W. J., and Dhont, J. Plasmocytoma (Multiple Myelomas, Kahler's Disease), and Its Attendant Disturbances in the Protein Metabolism, *Am J M Sc* **215** 405-410, 1948.

10 Purcell, H., and Brown, C. E. Localized Amyloidosis of the Urinary Bladder, *U S Nav M Bull* **46** 1607-1610, 1946.

11 Greenbaum, S. S., and Bauer, J. T. Primary Lichen Amyloidosis. Report of Necropsy, *Arch Dermat & Syph* **55** 251-255 (Feb) 1947.

12 (a) Lindsay.^{3c} (b) Atkinson.⁷ (c) Letterer, E., cited by Kolff and Dhont.⁹ (d) Teilum, G. Allergic Hyperglobulinosis and Hyalinosis (Paramyloidosis) in the Reticulo-Endothelial System in Boeck's Sarcoid and Other Conditions. A Morphologic Immunity Reaction, *Am J Path* **24** 389-408, 1948.

13 Kramer, R., and Som, M. L. Local Tumor-Like Deposits of Amyloid in the Larynx. Report of Case with Review of Literature, *Arch Otolaryng* **21** 324-334 (March) 1935.

tute part of the usual secondary amyloidosis, local deposits as part of the picture of generalized primary amyloidosis, and idiopathic, or primary, amyloid deposits. These workers reviewed the subject of idiopathic, or primary, amyloid deposits in the upper air passages and observed the following distributional frequency in the 95 reported cases at that time: larynx, 36 cases (37.8 per cent), tongue, 16 cases (16.8 per cent), trachea, 13 cases (13.8 per cent), and other sites, including the nose, pharynx, mouth and lungs, 30 cases (31.6 per cent). The greatest number of cases occurred in the sixth decade of life. Two additional cases¹⁴ of idiopathic amyloid deposits of the larynx have been encountered since the report of Kramer and Som. In Figi's case^{14b} dyspnea was prominent.



Fig 1 (case 1)—Appearance of subepithelial edema, fibrinoid changes of the connective tissue and a recent hemorrhage, $\times 266$

REPORT OF CASES

CASE 1—A man aged 39, a railroad switchman, complained of hoarseness and difficulty in swallowing for four months, which had become more marked during the past month. There were no other complaints, and the physical examination showed no abnormalities, except for a small firm red tumor at the anterior end of the left vocal cord. This lesion was removed by direct laryngoscopy.

Microscopic examination revealed a polypoid mass, partly covered by thick and thin segments of stratified squamous epithelium which showed keratinization. Heavy amyloid deposits were observed in the wall of and around the blood vessels.

14 (a) Clerf, L. H. Amyloid Tumor of the Larynx, *Arch Otolaryng* **36** 377-380 (Sept.) 1942. (b) Figi, F. A. Excision of Amyloid Tumor of the Larynx and Skin Graft. Report of a Case, *Proc Staff Meet, Mayo Clin* **17** 239-240, 1942.

Frequently, the amyloid masses protruded into the lumen of the blood vessels, pushing the endothelium before them and forming polypoid invaginations. At focal areas fibers of connective tissue were teased out, and these fibers were edematous in appearance and showed fibrinoid and granular degeneration. Multiple small recent hemorrhages were noted, at times around the amyloid. Hemosiderin deposits were present. A small ulcer was noted on one side.

CASE 2—A man aged 36, an automobile dealer, complained of having to clear his throat at frequent intervals and of hoarseness of five months' duration. The only other complaint was burning of the eyes for ten days. The physical examination disclosed nothing abnormal, except for a small reddish tumor, 3 mm in diameter, of the right vocal cord at the junction of the anterior and middle thirds. The cord was freely movable. The tumor was removed under direct vision.

Microscopic examination revealed a polypoid mass covered by thin, stratified squamous epithelium, which showed keratinization. The small blood vessels near



Fig 2 (case 2) —Appearance of ulceration, hyperemia and old hemorrhages, as represented by numerous hemosiderin-laden macrophages. The amyloid extends to the ulcer base, forming a portion of the base, $\times 200$

the epithelium were dilated with blood (hyperemia). The amyloid was deposited in and around the blood vessels. Focal fibrinoid degeneration of the connective tissue was noted. Small, recent hemorrhages and hemosiderin deposits were noted.

CASE 3—A man aged 50, rancher and smoker, had complained of hoarseness for one year. The hoarseness varied in intensity but never disappeared. There were no other complaints. The physical examination disclosed nothing abnormal except for red, pedunculated tumors attached to the inferior surfaces of the vocal cords anteriorly and to the left. Portions of these masses were removed on the first occasion, and the remainder was removed three months later.

Microscopic examination of the first specimen revealed polypoid masses partly covered by a thin, atrophic, keratinizing stratified squamous epithelium. The main substance of the masses consisted of amyloid deposits in and about the blood



Fig 3 (case 3) —*A*, higher magnification, showing amyloid in the wall of blood vessels and in the immediate environs. Notice how the blood vessels are collapsed and compressed. Connective tissue cells remain entrapped in focal areas. In other areas these cells are absent, leaving lacuna-like spaces, $\times 266$. *B*, polypoid invagination of a blood vessel. Notice the intact endothelial covering of the masses and the thrombus-like cross section to the left. The adjoining connective tissue is edematous, frayed and somewhat granular (fibrinoid). A smaller blood vessel shows amyloid confined within its wall, $\times 266$.

vessels. Polypoid invagination of the blood vessels was prominent and in cross sections resembled thrombotic masses. The blood vessels near the epithelium were dilated and filled with blood (hyperemia). The hyaline amyloid masses contained multiple lacuna-like spaces, apparently foci, where connective tissue or cells of blood vessel walls had been accommodated. Scattered recent interstitial hemorrhages

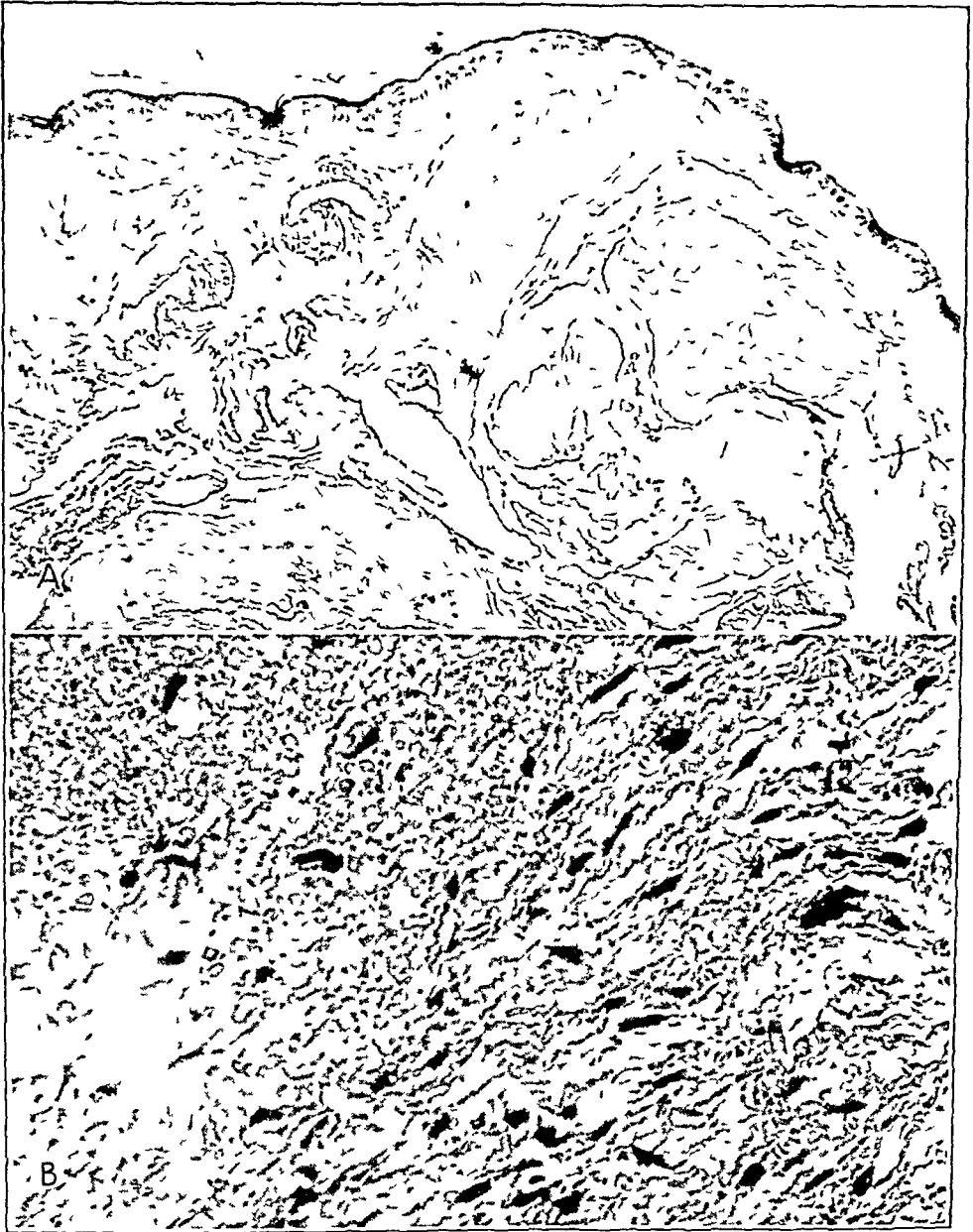


Fig 4 (case 4) —*A*, bulging of the mucosa due to subjacent amyloid deposits. The epithelium is atrophic and shows keratinization. Notice the irregular distribution of the amyloid masses and the zone of vascular connective tissue between the amyloid and the epithelium. At the center near the epithelium a crescent-shaped blood vessel shows recent hemorrhage into amyloid deposits in its wall, $\times 66$. *B*, higher magnification, showing fibrinoid degeneration of the connective tissue (fraying, smudginess, granularity) and a recent hemorrhage, $\times 466$.

were noted. Foci of granular and edematous and fibrinoid degeneration of the connective tissue were numerous. In these areas mild leukocytic infiltration was noted. One small ulcer with rolled edges was present. Hemosiderin deposits were prominent below the ulcer.

The second specimen revealed ulceration and subacute inflammation. The remaining epithelium showed hyperplasia and hyperkeratosis. Fibrinoid degeneration of the connective tissue was prominent in the areas adjacent to the amyloid deposits. The amyloid was again noted in the wall of and about the blood vessels.

CASE 4—A man aged 45, salesman and smoker, had been hoarse for two months. There were no other complaints. The examination showed no abnormalities except for a small reddish tumor, about 3 mm in diameter, attached to the left vocal cord near the anterior commissure.

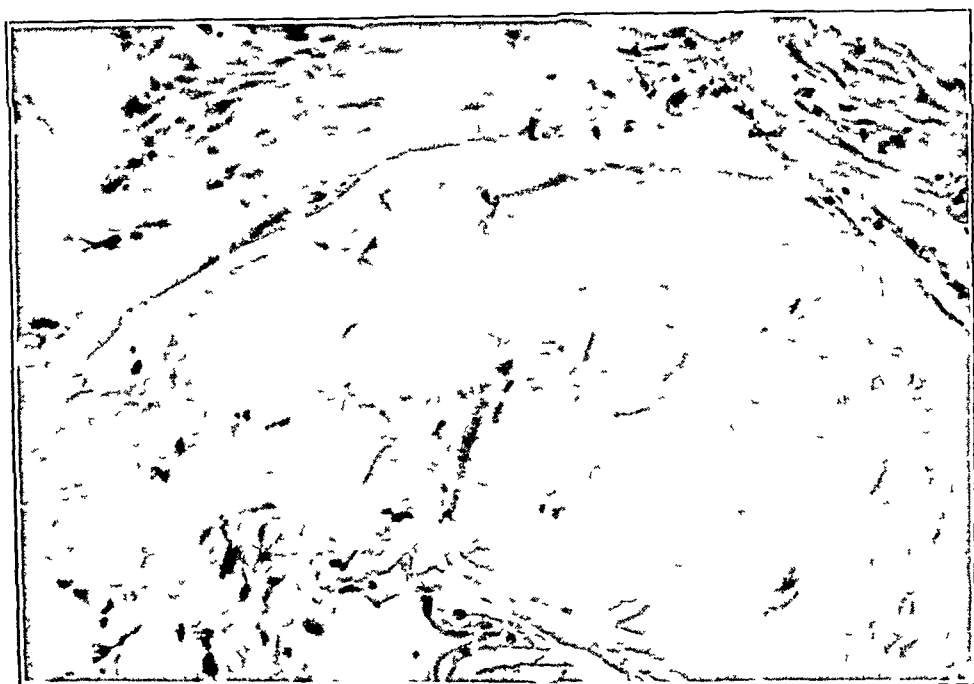


Fig 5 (case 5)—Amyloid pushing into a blood vessel. Notice the entrapped cells and lacuna-like spaces, $\times 266$.

Microscopic examination of the specimen revealed a polypoid mass, partly covered by keratinizing stratified squamous epithelium, which showed hyperplastic and atrophic zones. Amyloid in and around the blood vessels was noted to constitute most of the mass. Polypoid invagination of the vessels by the amyloid was frequent. Ulceration and subacute inflammation were present on one side. Other findings included recent hemorrhages, hemosiderin deposits and fibrinoid degeneration of the connective tissue.

CASE 5—A man aged 53, railroad switchman and smoker, complained of hoarseness of eight months' duration. The patient had had three colds and a periodic, nonproductive cough during the preceding year. Urinalysis showed frequent hyaline and granular casts and 75 mg per hundred cubic centimeters of protein. The only other positive finding was that of a red nodule, about 3 mm in diameter, at the junction of the anterior and middle thirds of the right vocal cord. The nodule was removed with biting forceps.

Microscopic examination revealed a rounded mass almost filled with amyloid deposits in and about the blood vessels. The amyloid contained many lacuna-like spaces. Polypoid invagination of the blood vessels by the amyloid was prominent. Hemosiderin deposits were scattered.

COMMENT

Amyloid deposits in the larynx have been observed in 5 cases over a period of twenty-four months in a surgical pathology service associated with two laryngology services. During the same period specimens from 31 laryngeal lesions were examined. These figures tend to agree with Beavis'¹ contention that this lesion is perhaps not as rare as one gathers from the frequency of reports.

The main complaint of hoarseness of several months' duration indicates a need of differentiating this lesion from neoplasms of the larynx. All subjects in the present report were men, and the ages

Clinical Data on Cases of Primary Amyloid Deposits in the Larynx

Case	Age, Yr	Sex	Occupation	Location	Symptoms
1	39	M	Railroad switchman	Anterior end, left vocal cord	Hoarseness, increasing
2	36	M	Automobile dealer	Right vocal cord, junction of anterior and middle thirds	Hoarseness, frequent clearing of throat
3	50	M	Rancher	Inferior surface of both vocal cords anteriorly	Hoarseness, varying intensity
4	45	M	Salesman	Left vocal cord anteriorly	Hoarseness, pro gressive
5	53	M	Railroad switchman	Right vocal cord, junction of anterior and middle thirds	Hoarseness, recent

ranged from 36 to 53 years (table). The occupations and personal habits did not appear to throw any light on the cause of this condition. All patients presented no other complaints. The findings in the urine of 1 subject were indicative of a nephropathy, but no other index of systemic amyloidosis was encountered. The cases in this series, therefore, seemed to belong to the category of primary amyloid deposits in the larynx.

These lesions in the larynx were of a polypoid nature and were associated with some segment of one or both vocal cords. Grossly, these were small red nodular masses. All lesions revealed certain similar patterns. The overlying epithelium was stretched and atrophic for the most part, but in foci exhibited hyperplasia. Keratinization was present on each occasion. The amyloid deposits constituted the main bulk of these masses. The amyloid was deposited in focal areas that tended to become confluent. These areas represented vascular zones, the amyloid seeming to accumulate in the vessel wall and adjoining connective tissue. At times remnants of blood vessels could be seen collapsed.

within the amyloid masses. Another feature of the amyloid was the presence of multiple lacuna-like spaces, which apparently formerly accommodated connective tissue cells. The bulging of the amyloid into the lumen of the vessel, pushing the endothelium before it, produced characteristic polypoid invaginations in each case. At times cross sections of these polypoid invaginations resembled thrombotic masses of amyloid.

The amyloid extended to subepithelial zones, but in all specimens a vascular connective tissue remained interposed between the amyloid and the epithelium at varying microscopic intervals. These blood vessels were well distended with blood. Thus, the hyperemia accounted at least in part for the reddish appearance of these masses, as seen by clinical visualization of the larynx. Recent microscopic hemorrhages were noted in 4 of the 5 cases, and hemosiderin deposits were present in all cases. The extravasated red blood cells were present in the connective tissue between amyloid masses. These areas of remaining connective tissue displayed prominent changes. The collagen fibers were teased out in the manner of an edematous area, and these teased fibers showed the granularity and the smudgy, eosinophilic, wavy appearance of fibrinoid degeneration. Scattered neutrophils and lymphocytes were noted in some areas. The blood vessels in these areas showed similar degenerative changes of their walls (edema, separation and "smudgy" change). Early amyloid deposits were at times noted in these zones.

Microscopic ulceration was observed in 3 of the 5 cases. In 1 case subacute inflammation extended from the ulcer base into the mass. The vascular and connective tissue degeneration together with the obvious trauma associated with movements of the vocal cords apparently constitute an adequate explanation for both recent and old hemorrhages and the ulcerations.

It is still too early to determine the outcome in these cases, both as to local recurrences and possible subsequent systemic manifestations. For periods up to twenty-four months these patients have not returned with the same complaints. Only 1 patient required two operations for complete removal. The other lesions were of minor proportions, causing functional disturbance by their special position only.

Other observers have noted the development of systemic or diffuse primary amyloidosis following what appeared earlier as a typical primary, or idiopathic, lesion of the upper air passages. It would seem, then, that the separation of the local nodular deposits from the systemic or disseminated deposition is not necessarily clearcut. So far the reports of the focal form have exceeded the cases of the systemic (disseminated) form by at least a factor of 2.

Huebschmann¹⁵ discussed fibrinoid changes in these lesions. In our cases this feature was striking in each instance. At times the smudgy, eosinophilic appearance of the connective tissue suggested the early phases of amyloid deposition. Therefore, it appeared that collagen degeneration constituted an integral part of the local process. The hemorrhages seemed partially related to a similar disintegration of the walls of the small blood vessels of the area.

It would seem that primary amyloid deposition may follow a pattern not unlike that of other mesenchymal diseases. Thus, there is a local form and a systemic or disseminated form, the former being more prevalent. The true relationship between these two forms has not been established. Moreover, fibrinoid degeneration of the adjoining connective tissue, at least at times, constitutes a part of the local process. This feature may not have any specific connotation, as emphasized by Baehr and Pollack,¹⁶ but should be appraised further.

SUMMARY

Five additional cases of primary nodular (idiopathic) amyloid deposits of the larynx are reported.

In a brief review of articles on amyloid deposits, emphasis is placed on classification and frequency of reports of each type.

The microscopic appearance of the lesions is discussed, the histologic features conform with reports in the literature except that the association of fibrinoid degeneration of collagen was more striking in these cases.

Primary amyloid deposits may be local or systemic (disseminated). The exact relationship between these two forms is not established at present, but, according to reports, may follow a pattern similar to that of other diseases involving mesenchymal structures.

Dr C. E. Gordon furnished the accompanying photomicrographs.

3301 Junius Street (1)

15 Huebschmann, P. Ueber Kehlkopfnoten mit sogenannten "amyloiden" Einlagerungen, Virchows Arch f path Anat **275** 698-710, 1930.

16 Baehr, G., and Pollack, A. D. Disseminated Lupus Erythematosus and Diffuse Scleroderma, J A M A **134** 1169 (Aug 2) 1947.

MONOSTOTIC FIBROUS DYSPLASIA

Report of Two Cases

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AND

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FIBROUS dysplasia is a benign tumor which may involve one, several or many bones. The osseous lesion is basically composed of fibrous connective tissue, throughout which are scattered irregularly shaped trabeculae of primitive bone. This name was first suggested by Louis Lichtenstein¹ in 1938 in an attempt to clarify the existing confusion regarding fibro-osseous disease. Previous to this time as many as thirty-three different titles had been used to describe this entity. Among the commonest are osteitis fibrosa, giant cell tumor, ossifying fibroma, fibrosarcoma, osteodystrophy, osteoid osteoma, fibroma, fibroseptic disease of bone and a form of von Recklinghausen's disease of bone. From the numerous titles used to describe fibrous dysplasia, it is readily seen that this lesion is not a rarity, however, owing to the comparatively recent recognition of this disease entity, many clinicians are relatively unfamiliar with it. This fact, as well as the fact that only 9 cases in which the maxilla was involved and 3 cases in which the frontal bone was involved have been reported under the title fibrous dysplasia, suggests reason for publication of this article.

REPORT OF CASES

CASE 1—The patient was a white soldier aged 18. In September 1944, his first right upper molar tooth was extracted, and a piece of the alveolar margin was removed with the tooth. On further inspection, a swelling was discovered over the right side of the maxilla and the right upper alveolar margin. The patient was advised to consult an oral surgeon. In June 1946, he entered the Army and immediately applied for admission to paratroopers' school. On preliminary examination, the swelling was again observed. He was then sent to a general hospital, where examination revealed no abnormality except for the swelling over the maxilla and the alveolar margin. Roentgenograms of the right maxilla

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1 Lichtenstein, L. Polyostotic Fibrous Dysplasia. Arch Surg 36:874-898 (May) 1938

revealed the antrum to be almost completely filled with soft tissue. Laboratory tests revealed no abnormalities. A clinical diagnosis of giant cell tumor was made.

On Aug 6, 1946, through a Caldwell-Luc approach, a section of bone approximately $\frac{1}{2}$ inch square (1 cm) was chiseled out of the right maxillary sinus. The antrum was curetted and the remaining tissue removed. Grossly, the pathologic specimen consisted of numerous bony fragments, the largest one measuring 2 by 2 by 1 cm, with a narrow rim of periosteum at one end. The other pieces averaged 3 to 6 mm in size. The tissue was brownish gray and appeared to have bony trabeculae dispersed throughout the fibrous tissue. Histologically it was composed of moderately cellular connective tissue, in which there were numerous masses of osteoid tissue showing a gradual transition between connective and osteoid tissue. A few well formed trabeculae, irregular in shape and variable in size, were present. Many of these were covered with osteoblastic cells and an

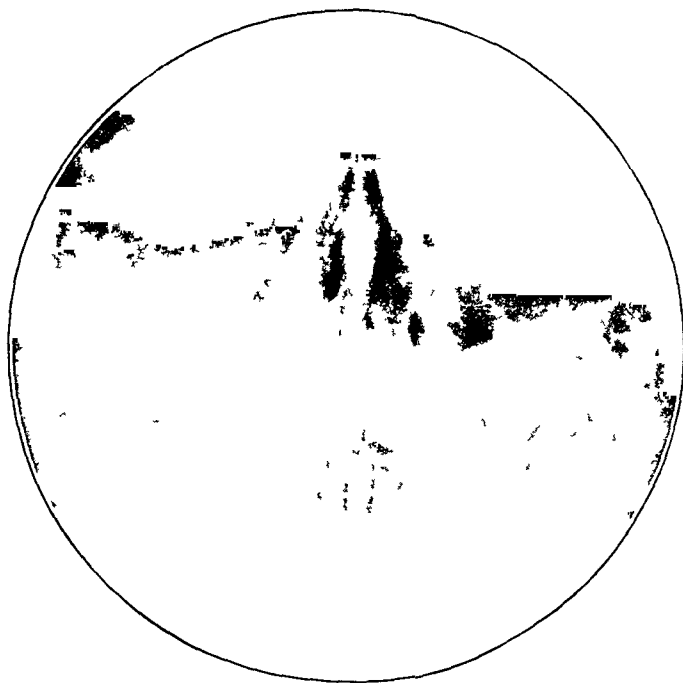


Fig 1 (case 1) —Roentgenogram of maxillary sinuses taken in February 1947, showing involvement of right maxillary sinus and maxilla.

occasional multinucleated osteoblast. A section taken through the cortex showed the tissue to be extremely thin and absent in some areas. The pathologist stated that the tumor resembled both osteoid osteoma and fibrous dysplasia. The distinct thinning of the cortex without bony proliferation was against the diagnosis of osteoid osteoma, but the large amount of osteoid tissue was in favor of such a diagnosis, however, it was considered that the lesion more closely resembled fibrous dysplasia.

During the next six months after the operation, the right antrum gradually became filled with this soft tissue. In February 1947, the patient was transferred to Walter Reed General Hospital. The examination here revealed nothing significant except the generalized enlargement of the maxilla and swelling of the right alveolar ridge and right side of the hard palate. Roentgenograms of the right side of the maxilla revealed the right maxillary sinus to be considerably smaller than the normal left. There was extreme enlargement of the right side of the

maxilla, which had produced an elevation of the floor of the right orbit, thickening of the right infraorbital ridge and alveolar process and depression of the right side of the hard palate. The right malar bone was displaced laterally, and there had been a partial dislocation of the malar-maxillary articulation. The enlarged maxillary bone was of homogeneous density, about equal to that of normal bone. Skeletal survey of the long bones and roentgenograms of the chest revealed nothing abnormal. A roentgen diagnosis of fibrous dysplasia was made. Results



Fig 2 (case 1) —Photomicrograph showing trabeculae of osteoid tissue scattered throughout fibrous connective tissue

of urinalysis were normal, and the Kahn reaction was negative. The blood phosphatase activity was 0.35 Bodansky unit and the cholesterol level 196 mg per hundred cubic centimeters, the serum phosphorus and calcium levels were 3.5 and 10.8 mg, respectively, the blood creatinine level, 1.2 mg. The total protein content was 6.9 Gm per hundred cubic centimeters (serum albumin 4.62 Gm and serum globulin 2.28 Gm). Tests for Bence Jones protein gave negative results. The urinary calcium level was 15.3 mg.

On February 27, through a Caldwell-Luc approach, the right antrum was exposed and found to be completely filled with spongy tissue. This tissue was removed with a curet. The tumor extended upward to the floor of the orbit but did not penetrate it, anteriorly, the cortex was decidedly thinned. The antrum was packed with gauze and the incision closed. The gross and microscopic appearance of the tissue was essentially the same as previously reported. During the following six weeks, the antrum again gradually filled with tumor tissue. On April 17, the right antrum was again opened. The operator had intended to remove the tumor completely, but the maxilla was so extensively involved that this was impossible. The incision was closed after the tumor mass was removed from the antrum only. Examination of the neoplastic tissue again showed conditions similar to those noted on previous biopsies. No malignant changes were found. After this removal, the tumor again filled the sinus. Roentgenograms taken approximately every six weeks for eight months did not show any further extension of the neoplasm. Skeletal surveys and roentgenograms of the chest also indicated nothing abnormal. The patient was discharged asymptomatic on Jan 7, 1948.

CASE 2—A 25 year old white soldier, in January 1944, complained of pain over the left upper incisor tooth, radiating to the left maxillary area. The tooth was extracted at that time, and the pain disappeared for approximately eight months. In September he complained of what he called sinus trouble. This condition was characterized by alternating nasal obstruction, postnasal discharge (usually yellowish but never blood tinged) and pain over the left maxillary area and alveolar margin. These episodes of pain continued intermittently and gradually became progressively worse, usually being severest during cold weather. Nose drops alleviated this pain temporarily. In June 1946, on his return from overseas, the pain became rather severe and the patient reported to the nearest medical installation. An attempt was made to irrigate the left antrum, but because of the density of the lateral nasal wall, the clinician was unable to penetrate it. Further treatment was contemplated, but the symptoms subsided and the soldier failed to return. Shortly thereafter, he was transferred to cold climatic regions, and the symptoms again returned in September 1947. On examination a tumor was discovered involving the frontal ethmoid and turbinate bones on the left. He was then transferred to Walter Reed General Hospital. The past history was noncontributory except for injury incurred when the patient was struck with a ball bat over the left maxilla in 1938.

On inspection the most prominent feature was an enlargement of the left supraciliary ridge, which was smooth and hard. On palpation no tenderness was found. Examination of the nasal cavity revealed that all the turbinate bones in the left nostril were exceptionally enlarged and covered with pale mucous membrane. After the nose was sprayed with 1 per cent phenylephrine hydrochloride (neo-synephrine hydrochloride®) the turbinate bones on the left remained approximately the same size while on the right they constricted normally.

Roentgenograms of the skull and facial bones showed the left nasal passage to be obstructed by a dense radiopaque mass. The orbital plates of the left frontal bones were thickened and increased in density. The glabella, the greatest point of thickness, was 4 cm in width. The region of the frontal sinus was replaced with dense homogeneous material of a ground glass appearance. The ethmoid cells on the left were completely obliterated and replaced with tissue of this ground glass appearance. The right ethmoid cells were displaced to the right. The roentgen diagnosis was fibrous dysplasia. Laboratory studies yielded the following data: serum calcium 10 mg per hundred cubic centimeters, serum phosphorus

37 mg and serum phosphatase activity 64 Bodansky units, all these values were within normal limits. The erythrocytic and leukocytic counts and results of urinalysis were all essentially normal.

On Oct 16, 1947 a specimen for biopsy was taken from the left inferior turbinate bone. Under local anesthesia, a piece about 0.5 cm in diameter was removed from the anterior tip of the inferior turbinate bone. At the time of operation it was found that this bone was about six times its normal size. A small amount of bleeding occurred but was readily controlled with epinephrine. The pathologic report was as follows: The specimen consisted of a flat pinkish gray mass, 1.1 by 0.8 by 0.3 cm in size. It was covered on one surface by a finely granular epithelium, the under surface had a smooth, glistening appearance. The bone present was 4 mm in diameter and yellowish white. Microscopically it was found to be essentially normal cancellous bone showing myelofibrosis. On November 21, another specimen for biopsy was taken in a similar manner from the same turbinate



Fig 3 (case 2) —Lateral view of skull showing involvement of orbital plates of frontal bones, with obliteration of both frontal sinuses

bone near the middle portion. This specimen grossly consisted of four irregularly shaped yellowish white pieces of osseous material. On section the material was yellowish white and of uniformly hard consistency, with the exception of a small amount of soft osseous tissue seen at the base of one piece. Microscopically the mucous membrane showed a chronic inflammatory reaction, and the osseous tissue showed myelofibrotic changes compatible with early fibrous dysplasia.

REVIEW OF LITERATURE

In the past, fibro-osseous lesions of the bone were usually classified as Paget's or von Recklinghausen's disease. It was not until 1922 that Weil² first reported a case of fibro-osseous disease of the bone associated

² Weil, A. Pubertas praecox und Knochenbruchigkeit, Klin Wchnschr 1 2114-2115, 1922

with an extraskeletal lesion. In this case there was no accompanying hyperparathyroidism. During the ensuing fifteen years there were few cases of this type recorded. In 1937 McCune and Bruck³ reported a case of osteodystrophia fibrosa, with pathologic pigmentation of the skin and precocious puberty. This was the first time that the lesion had been recognized as a distinct entity. In 1937 Albright, Butler, Hampton and Smith⁴ described what is now called the Albright syndrome. It is characterized by osteitis fibrosa disseminata, precocious puberty in

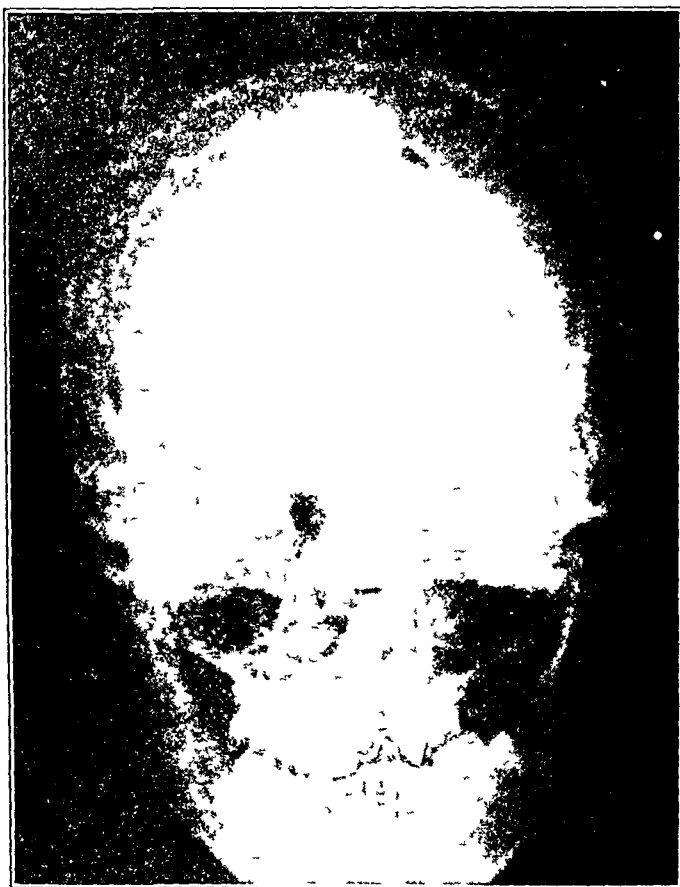


Fig 4 (case 2) —Anteroposterior view of skull showing involvement of left inferior turbinate bone, left ethmoid bone and both frontal bones

the female, endocrine dysfunction and pathologic areas of pigmentation. In 1938 Lichenstein¹ published a report of 8 cases in which there were multiple bone involvement and extraskeletal changes. He sug-

3 McCune, D. S., and Bruck, H. Osteodystrophia Fibrosa, *Am J Dis Child* 54 806-848 (Oct) 1937

4 Albright, F., Butler, A. M., Hampton, A. O., and Smith, P. Syndrome Characterized by Osteitis Fibrosa Disseminata, Areas of Pigmentation and Endocrine Dysfunction, with Precocious Puberty in Females, *New England J Med* 216 727-746, 1937

gested the term fibrous dysplasia of the bone. In 1942, Lichtenstein and Jaffe⁵ made a comprehensive review of the literature and compiled 90 cases, 15 of their own and 75 previously reported under a variety of titles. The sex of 86 patients was known, 60 per cent of these were female. Pathologic cutaneous pigmentation was found in 35 per cent, and in nearly all of these there was multiple bone involvement. Evidence of

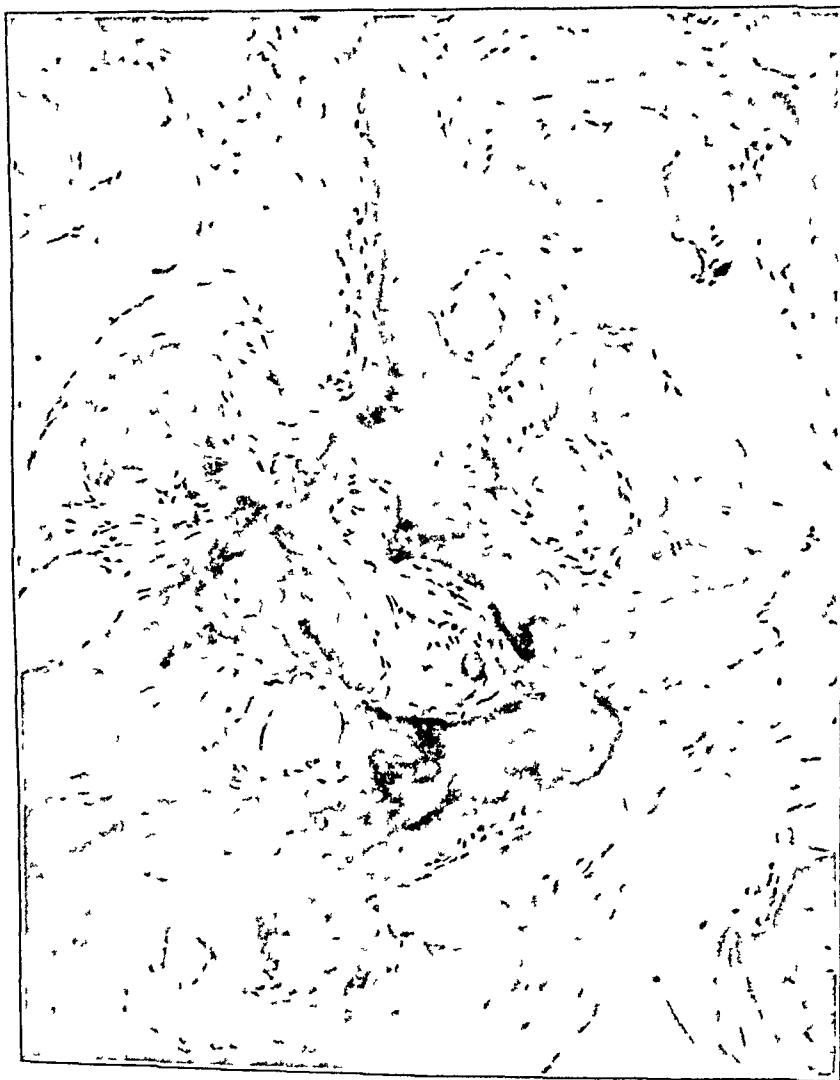


Fig 5 (case 2)—Photomicrograph showing myelofibrotic changes compatible with early fibrous dysplasia

endocrine dysfunction was discovered in 22 per cent, all of whom were female. Fifteen of the 87 patients, or approximately 17 per cent, had involvement of a single bone. The maxilla was the most commonly involved facial bone. Although in only about one fifth of the reported

⁵ Lichtenstein, L., and Jaffe, H. L. Fibrous Dysplasia of Bone, Arch. Path. 33:777-816 (June) 1942

cases were the lesions of the monostotic type. Lichtenstein and Jaffe stated the opinion that such lesions were much commoner than this figure would indicate. This hypothesis was later proved by Schlumberger's⁶ report of 67 cases of monostotic fibrous dysplasia in 1946. In his cases the various bones involved were as follow: rib, 29, femur, 9, tibia, 8, humerus, 2, ulna, 2, vertebrae, 1, pelvis, 1, fibula, 1, mandible, 2, maxilla, 7, frontal, 2, parietal, 1, mastoid, 1, and occipital, 1. It is interesting from the standpoint of the otorhinolaryngologist to note that the facial bone was involved in about 20 per cent of the cases, and in half of these the lesion was located in the maxilla. Schlumberger found no extraskletal defects or congenital anomalies in these 67 cases. The average age at onset was 26 years, but this figure had little significance, since study was limited to the military age group. Coley and Stewart⁷ reported the only 2 cases of fibrous dysplasia in which a sarcoma appeared. Both sarcomas were of the non-bone-forming type, occurring in the scapula and left hip.

ETIOLOGY

The cause of this disease entity is unknown. It was first believed to be a unilateral form of von Recklinghausen's disease. Albright and his associates first suggested that fibrous dysplasia might be directly related to an endocrine dysfunction, later they thought it was a disseminated neurologic disease, with a lesion in the vicinity of the third ventricle to account for the precocious sexual development. Lichtenstein and Jaffe⁵ advanced the hypothesis that the disease was due to a skeletal developmental anomaly resulting apparently from perverted activity of the specific bone-forming mesenchyma. Snapper⁸ expressed the opinion that fibrous dysplasia was not a disease entity, but merely an atypical expression of Hand-Christian-Schüller disease (lipid granulomatosis, xanthomatosis). In 1944 Thannhauser⁹ again revived the theory that it was not a distinct disease entity but merely a manifestation of neurofibromatosis, or von Recklinghausen's disease. This supposition was refuted by Jaffe¹⁰ in 1945. He stated that skeletal changes observed in cases of fibrous dysplasia, which are of consistent

6 Schlumberger, H. G. Fibrous Dysplasia of Single Bones, *Mil Surgeon* **99** 504-527, 1946.

7 Coley, B. L., and Stewart, F. W. Bone Sarcoma in Polyostotic Fibrous Dysplasia, *Ann Surg* **121** 872-881, 1945.

8 Snapper, I. Medical Clinics on Bone Diseases. A Text and Atlas, New York, Interscience Publishers, Inc., 1943, pp 157-171.

9 Thannhauser, S. J. Neurofibromatosis (von Recklinghausen) and Osteitis Fibrosa Cystica Localisata et Disseminata (von Recklinghausen), *Medicine* **23** 105-149, 1944.

10 Jaffe, H. L. Fibrous Dysplasia of Bone: Disease Entity and Specifically Not an Expression of Neurofibromatosis, *J Mt Sinai Hosp* **12** 364-381, 1945.

pattern and indeed constitute its central feature, are by no means analogous, roentgenographically or anatomically, with the highly various skeletal changes found in cases of neurofibromatosis. Recently, Schlimmberger⁶ advanced the theory that this lesion represented an abnormal response to injury, since a history of trauma was present in almost one third of the cases, although there was no proof that fibrous dysplasia did not exist previous to this time. It was also his opinion that the monostotic type was not a congenital anomaly and etiologically had nothing in common with the form of polyostotic fibrous dysplasia found in Albright's syndrome.

PATHOLOGY

Grossly, the involved bone shows a replacement of the spongy bone of the marrow cavity by evenly whitish or reddish-speckled rubbery compressible tissue. Occasionally it is described as gritty in part or throughout, owing to the presence of formed trabeculae of immature bone. The cortex of the bone is usually thinned or entirely absent in parts because of pressure from the expanding tumor.

Microscopically the lesion is composed essentially of fibrous tissue throughout which are scattered trabeculae of poorly formed primitive bone. The connective tissue in the affected area is rather cellular and made up of immature, small, slender, spindle-shaped cells arranged in a rather loosely whorled manner. Occasionally the lesion may be poorly cellular and highly collagenous in character. The trabeculae are of variable size and shape and are irregularly distributed throughout the lesion, though they are greater in number in the more cellular and vascular areas. No mature lamellas are seen in these trabeculae, which are usually formed by a typically calcified metaplastic fibrous bone.

Infrequently, focal degeneration or hemorrhage may result in the formation of cysts. In these areas, multinuclear giant cells and a few nests of foam cells may be seen. At the location of a pathologic fracture, islets of cartilage have been found by some observers, but they have been rarely seen in other locations.

CLINICAL MANIFESTATIONS

Usually the first sign of disease in the monostotic form is a local swelling over the affected area if the bone is superficial, as a rib, clavicle, maxilla or calvarium, but often the disease is discovered only on routine roentgen examination. Occasionally tenderness may be located over the lesion. Pain is not a characteristic symptom, and for this reason the tumor may be present for many years before it is revealed. When one bone is involved, it is most frequently the tibia or femur in the lower extremity, the humerus or ulna in the upper extremity and the maxilla

in the facial bones. Extraskkeletal abnormalities have never been reported in monostotic fibrous dysplasia, however, in the polyostotic type they may occasionally be seen, especially if the osseous involvement is extensive. By far the commonest abnormalities are pathologic pigmentation of the skin, usually over the neoplasm and premature sexual maturation and skeletal growth.

In the polyostotic type, the osseous lesions are usually confined to one limb, or, at least, there is a heavier involvement of the bones on one side of the body when the bones of the face, skull, thorax and extremities are implicated.

The blood chemistry, which includes serum calcium, serum phosphorus and serum phosphatase levels, is within normal limits, although in some cases it has been reported as being at the upper limits of normal. This is true whether there is involvement of one, few or many bones.

Roentgenographic findings are often difficult to interpret in the monostotic form. The appearance of the bone depends on the composition of the tissue in the medullary cavity and the effects of this material on the cortex of the bone. If the interior of the bone is replaced by a tissue of a more fibrous than osseous character and has in places become cystic, the area will be radiolucent and cast a corresponding shadow. In the lesions in which the abnormal medullary tissue has undergone ossification, this tissue will usually present a ground glass appearance. At times, this fibro-osseous tissue erodes through the original cortex and causes a furrowing of the bone. This presents a multilocular appearance on roentgenograms, though the bone is filled solidly with a dysplastic connective tissue.

DIAGNOSIS

For a diagnosis of fibrous dysplasia, the clinical manifestations, including the roentgen findings, are usually sufficient in cases of the polyostotic form, however, this is not true in cases in which a single bone is involved. In such cases, it is difficult to distinguish the solitary lesions roentgenographically from enchondromas, bone cysts, giant cell tumors, osteochondromas, chondromas, sarcomas and fibromas. Schlumberger⁶ listed these lesions as those most frequently mistaken for a lesion of monostotic fibrous dysplasia. A biopsy is necessary to rule out such a possibility.

The polyostotic type, hyperparathyroidism, enchondromatosis and Hand-Christian-Schuller disease raise the greatest problem in differential diagnosis.

Lesions of the maxilla, such as we have reported in this article, have been frequently diagnosed as ossifying fibroma. Lichenstein¹

Mallory,¹¹ and Schlumberger¹² stated that ossifying fibroma is merely a variant of fibrous dysplasia and not a separate disease entity. They arrived at this conclusion after comparing the histologic and roentgenologic findings of ossifying fibroma with those of fibrous dysplasia located in other parts of the skeleton. The only variation between the two was that in ossifying fibroma the trabeculae were spherical, whereas in fibrous dysplasia they were more elongated.

PROGNOSIS

In the monostotic form of fibrous dysplasia, Lichtenstein and Jaffe⁶ stated that the outlook is good as to normal life expectancy. Lesions which are present before skeletal growth ceases usually slow down and become arrested when adult life is reached. In cases of multiple bone involvement, the prognosis is about the same, except when extraskeletal abnormalities are associated with the disease. Coley and Stewart⁷ recently reported 2 cases of the polyostotic type of fibrous dysplasia in which non-bone-forming sarcomas developed in another area. There have been no reports of malignant transformation in the monostotic fibrous dysplasia.

TREATMENT

The treatment of this disease should be governed not by the number and size of the lesions but, rather, by the severity of the symptoms. In cases of solitary lesions which are nonsymptomatic, only a biopsy should be performed to confirm the diagnosis. No further operative procedure is necessary in these cases. If a single lesion causes difficulty and is not located in the weight-bearing bones, such as the tibia and femur, it should be thoroughly curetted and the cavity filled with autogenous bone chips. This usually eradicates the disease. The former statement applies to all cases except those in which the ribs or facial bones are involved. When incapacitating lesions are located in these areas, resection is usually the procedure of choice. In weight-bearing bones in which pathologic fracture has occurred, a massive autogenous graft has been used with great success, although fractures have recurred. All surgical procedure except for biopsy purposes should be avoided, if possible.

329 South Oak Park Avenue

¹¹ Mallory, T. B. Pathology Diseases of Bone, New England J Med **227** 955-960, 1942

¹² Schlumberger, H. G. Fibrous Dysplasia (Ossifying Fibroma) of the Maxilla and Mandible, Am J Orthodontics **32** 579-594, 1946, footnote 6

Case Reports

RHABDOMYOSARCOMA OF THE MIDDLE EAR

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Although malignant growths of the middle ear do not occur frequently, various types of such tumors have been reported in the world literature. The case presented here is of special interest because no such case was found reported in the available literature.

REPORT OF A CASE

A Negro girl aged 3 was admitted to Babies Hospital on Jan 10, 1945, with paralysis of the left side of the face and slight bleeding for five days from a tumor in the left external auditory meatus.

The family and past histories were noncontributory.

Examination—The patient was a well developed, thin child weighing 14 Kg. There was complete paralysis of the left side of the face. Cervical nodes were palpable in both the anterior and the posterior region. Examination of the left ear revealed a finger-like mass protruding from the external auditory canal. The drum membrane could not be visualized. The other clinical and laboratory findings were normal. Roentgenographic examination of the temporal bone showed a well pneumatized mastoid, with slight haziness of the cells on the left side.

A biopsy specimen was taken from the mass, and a diagnosis of granuloma was reported on January 15. In view of the clinical picture, which was strongly suggestive of a tumor, the biopsy was repeated on January 15 and the diagnosis was again granuloma.

Operation—On January 18, a radical mastoidectomy was performed on the left side. The mastoid cells were well developed and lined with swollen mucosa. A greenish blue exudate filled the mastoid cells. The facial ridge, the zygomatic region and the bridge were soft and easily broken down with curets. The antrum and the middle ear were filled with a tumor, which seemed to originate from the anterior part of the middle ear. This mass protruded through the external auditory meatus. The drum membrane and the ossicles were destroyed except for the head of the malleus, which was found embedded in the tumor. The tumor was removed as completely as possible, a plastic flap was made and the cavity was packed with gauze.

Microscopic Examination of Operative Specimen (Dr D H Anderson)—The appearance of the tumor varied somewhat in different areas. The portion which appeared to be growing most actively was that beneath the surface. Here the tissue was extremely cellular, with poorly defined cell outlines and large pale nuclei, which tended to be oval but were often irregular in size and shape. They had a coarse network of fine fibers and contained one or two distinct nucleoli.

This study was assisted by grants from the Research Council of the American Otological Society and the Hayden-Coakley Fund.

From the Department of Otolaryngology of Columbia University College of Physicians and Surgeons, and the Presbyterian Hospital, New York.

There were as many as fifteen mitotic figures in one high power field. This area was well supplied with thin-walled vessels. In many other areas the majority of the nuclei were pyknotic and often elongated and distorted, but there remained some nuclei similar to those first described, in other areas they were elongated and resembled fibroblasts. They were arranged in irregular whorls and suggested in appearance an exaggeration of the active growth of fibroblasts in granulation tissue. In several places the squamous epithelium on the surface had become necrotic, with an inflammatory reaction in the underlying tumor tissue.

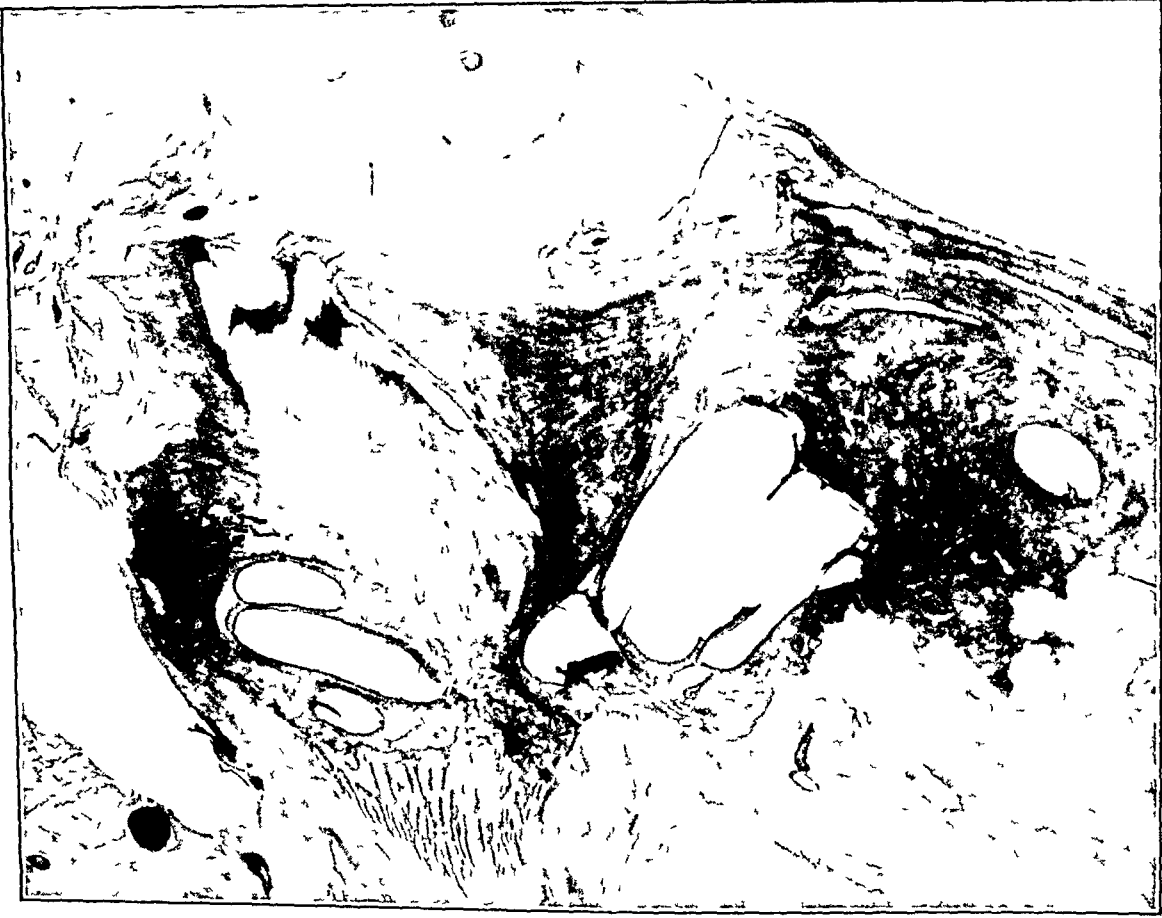


Fig 1—Ingrowth of tumor tissue from the middle ear into the vestibule, destruction of the annular ligament, luxation of the stapes. Erosion of the labyrinthine capsule, new formation of bone over the promontory, tumor masses in the dura and in the internal auditory meatus.

Trichrome Stain In the most actively growing areas first described, there was still little or no fibrillar tissue. Elsewhere, where the nuclei suggested the appearance of fibroblasts, they were separated by fine strands of collagenous fibers.

Foot Stain In the actively growing areas a fine reticulum separated the cells into groups of three to six and sometimes surrounded individual cells. In the areas where the nuclei were elongated many coarse fibers were found, these fibers ran parallel to the long axis of the cells and often separated groups of several cells.

Diagnosis—The diagnosis was undifferentiated malignant tumor of the temporal bone (sarcoma or fibrosarcoma?).

Postoperative Treatment and Course—On February 2, roentgen therapy was begun. From February 10 to March 9, a total of 2,200 r was given to the region of the tumor, with 200 kilovolts, 25 milliamperes, a total skin distance of 50 cm and 1 mm of copper filtration.

Although the clinical examination of the nasopharynx revealed nothing noteworthy except for a small amount of adenoid tissue on the roof, a biopsy specimen of this tissue was taken in order to detect a possible extension of the tumor to this area. The specimen was reported as being adenoid tissue.

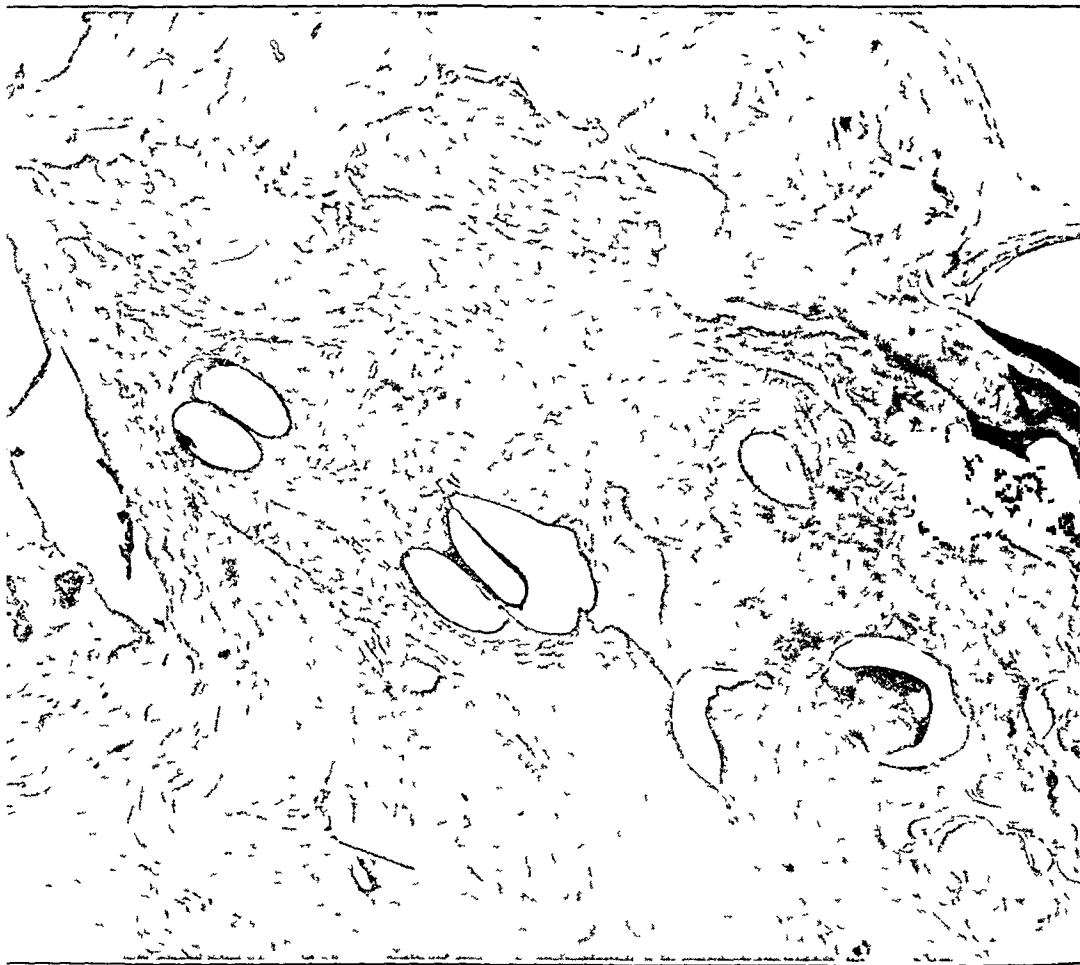


Fig 2—Progressive erosion of the labyrinthine capsule, middle ear filled with tumor tissue, round window membrane intact

A neurologic examination on February 18 revealed paralysis of the left sixth and seventh cranial nerves of peripheral type and questionable paralysis of the twelfth nerve on the left side. The involvement of the seventh nerve was undoubtedly of otic origin, and that of the sixth nerve was probably due to involvement of the left petrous pyramid.

After the operation, the tumor recurred rapidly and broke through the post-auricular wound and the external canal. On April 13, definite paralysis of the left hypoglossal nerve was noted. On March 13, a small marginal infiltration of the

cornea and complete ophthalmoplegia, probably due to the spreading of the tumor into the apex of the left orbit, were noted

Radium was given, without benefit, and the patient died on May 10

Autopsy—Postmortem examination of the head and brain showed a creamy, soft tumor, measuring 13 by 13 by 3 cm, in the left mastoid region. On the cut surface the tumor was seen to be divided into small lobules. The tumor extended into the left temporal cavity through a large hiatus behind the left ear. Almost no bony base remained in the middle cranial fossa on the left, and the tumor extended downward into the soft tissues of the neck and anterior to the external ear, as well as into the adjacent portion of the sphenoid bone and into the left orbit.

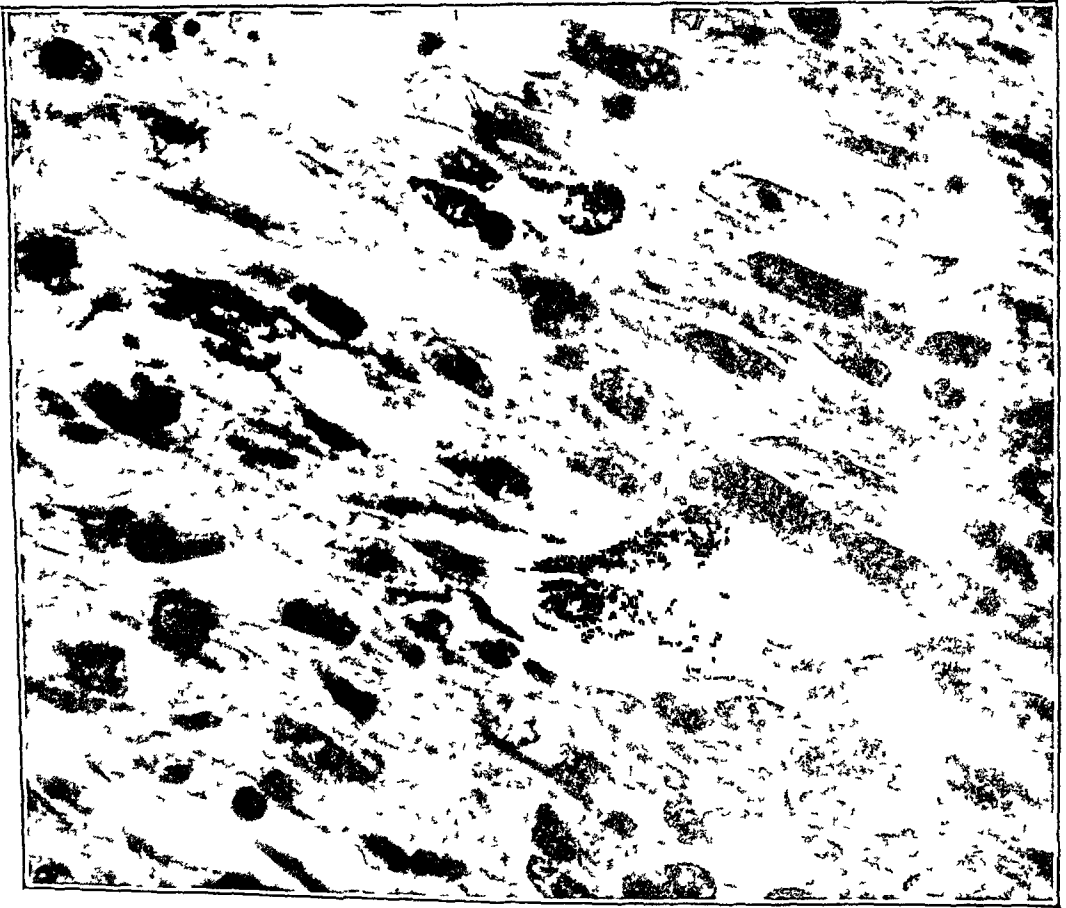


Fig 3—Rhabdomyoblasts in the tumor tissue

The growth, replacing the petrous pyramid, extended to the cerebellopontile angle without invading the parenchyma of the cerebellum and the brain. A large mass was also present in the pharynx as a direct extension from the tumor in the neck.

Microscopic Examination of Left Temporal Bone (horizontal serial sections)—The large operative defect following radical mastoidectomy was filled with the tumor, all the contents of the middle ear were destroyed, with the exception of the foot plate of the stapes and a part of its anterior crus (fig 1). The tumor had destroyed almost the entire annular ligament. The foot plate of the stapes was luxated and its anterior part pushed into the perilymphatic cistern (fig 1).

The tumor had destroyed large areas of the inner table of the mastoid, the tegmen tympani, the tympanum and the osseous carotid canal

The labyrinthine capsule was almost everywhere eroded by the tumor, which in some places reached the endosteum. It did not, however, invade the perilymphatic spaces except where it grew through the oval window into the vestibule. In some places, particularly over the promontory, new formation of weblike, fibrillar bone in netlike arrangement was noticed (fig 1)

The round window membrane was intact (fig 2)

The petrous pyramid and the eustachian tube were almost completely destroyed. The tumor grew into the nasopharynx, infiltrated large areas of the outer layers of the dura, extended to the periosteum of the internal auditory meatus and penetrated through it, in several places. The nerves in the internal auditory meatus were infiltrated. At other points the growth extended around the inferior and posterior borders of the labyrinthine capsule to the dura of the posterior fossa and from there to the internal auditory meatus.

The portion of the facial nerve in the middle ear had been completely destroyed, and the tumor could be followed along the original course of the nerve to the geniculate ganglion and from there into the upper part of the internal auditory meatus. Here the tumor connected with extensions which had broken through the periosteum of the internal auditory meatus.

The infiltration of the cochlear nerve extended into the spiral ganglion of the basal turn of the cochlea and from there into the scala tympani. Along the branches of the vestibular nerve it extended a short distance into the osseous canals but did not reach the maculas and cupula.

The labyrinthine spaces showed a diffuse serofibrinous inflammation.

Reexamination of the tumor by Dr. A. P. Stout showed a myxoid structure in some areas and rhabdomyoblasts, some of them with unmistakable cross striations, in other parts (fig 3).

Pathologic Diagnosis—The final diagnosis of rhabdomyosarcoma was made.

SUMMARY

The case is reported of a Negro child $3\frac{1}{2}$ years of age with rhabdomyosarcoma which originated in the left middle ear.

180 Fort Washington Avenue

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

FUNCTIONAL EXAMINATION OF HEARING

ALFRED LEWY, M D

SHERMAN L SHAPIRO, M D

AND

NORMAN LESHIN, M D

CHICAGO

STEADY but not outstanding progress has been made in both the field of hearing tests and the field of hearing aids. Apparently American instruments are preeminent in the latter field. Contributions from Eastern and Central Europe are still rather scarce. A few original methods of testing hearing are suggested by foreign authors.

TESTS METHODS, INSTRUMENTS AND PRINCIPLES

Egan¹ presents procedures which have been found particularly useful in measurement of intelligibility of speech. These methods are classified into three groups: articulation tests, subjective appraisals and threshold tests. For a quantitative measure of the intelligibility of speech, an announcer reads aloud lists of syllables, words or sentences to a group of listeners, and the percentage of items correctly recorded by these listeners is called the articulation score. This score depends on various factors, such as the nature of the test items that constitute the discrete speech units and the procedures used in testing articulation. The speech units should be representative of conversational speech and grouped into balanced lists, each list as difficult as the others. The units should be representative of fundamental speech sounds. The type used whether nonsense syllables, words or sentences depends on a number of considerations. For use of nonsense syllables a trained testing crew is essential, for words, whether they are short or long, and for sentences, the psychologic factors are of greater importance. Intelligibility of discrete sentences is typically higher than of word or syllable articulation, since the percentage of key words recorded depends not only on articulation but also on the relation they bear to the other words of the sentence. For an extensive testing program a large number of reasonably short and homogeneous test lists should be used. The difficulty of the items in most tests follows

¹ Egan, J P. Articulation Testing Methods, *Laryngoscope* 58: 955 (Sept) 1948

a bell-shaped curve Egan describes the available lists of syllables, words and sentences The most recent revision of the nearly phonetically balanced word lists (P B) are presented, and the complete twenty lists are appended to the article for the use of other investigators The spondaic word lists are those in which words are used having homogeneous audibility, including especially those words with dissyllables spoken with equal stress on the two syllables These words are called spondees, and many such words have been recorded phonographically to determine with precision the threshold of hearing for speech The various lists are discussed These are of value in special circumstances, as for testing the speaking ability of persons who do much talking over the telephone

All articulation scores are relative, depending on the use of specific announcers, microphones, amplifiers, ear phones, noises, listeners and test lists Egan discusses all these factors and the means employed for their proper selection and use

An abbreviated test can be made by using test words recorded phonographically The listener has in front of him, on a card covered with a blank card, the same list as that on the recording After he hears the word and decides what he thinks it is, he uncovers the card and checks whether he has heard it correctly or not Egan describes three methods for determining the threshold of detectability and intelligibility For determining the threshold of detectability, the listener adjusts some variable until he is just able to detect the presence of speech sound about half the time This threshold is the reference level for the specification of the sensation level of speech At about 8 decibels above this threshold he will be able to understand with difficulty the gist of connected discourse This level is called the level of perceptibility To determine the threshold of intelligibility, the listener adjusts some variable until in his judgment he is just able to obtain without perceptible effort the meaning of almost every phrase of connected discourse read to him These thresholds are useful in determining the relative effectiveness of various types of noise in masking speech Determination of any one of these thresholds as a function of the intensity of the masking noise shows how the intensity of noise and speech are related so that a constant perceptual effect is maintained An appendix of twenty lists, each consisting of fifty common English monosyllables, accompanies the article These are phonetically balanced, and each of the lists is nearly as difficult as the other

Van Dishoeck and van Gool² have developed a method for quickly and easily obtaining a detailed audiogram showing all dips and defects

² van Dishoeck, H A E, and van Gool, J The Detailed Audiogram, *Arch Otolaryng* 47 149 (Feb) 1948

of hearing in the tonal range. An audiometer of the sweep frequency type is necessary. The intensity knob is fixed at the 0 decibel level. The frequency knob is then turned from low to high, and the tonal range in which the howling tone is heard is recorded by means of a simple writing mechanism mounted on the frequency knob. The intensity is then increased each time by 5 to 10 decibels till the howling tone is heard over the whole tonal range. This requires less time than the ordinary audiogram and, in addition, picks up all the dips and defects in the tonal range. The article has a more detailed description of this method with accompanying illustrations of this new detailed audiogram.

Jones³ points out that errors in the present diagnostic methods and tests used in the measurement of hearing warrant an accurate reevaluation. Some of these errors are due to acceptance of time-honored and improved theories as facts, such as Bezold's hypothesis, in which the explanation of the increase in hearing by bone conduction in tympanic disease is not altogether clear. The personal equation error, on the part of both patient and physician, is evident in instances of tests made by the same examiner of the same patient at different periods of the day showing a definite variance. Fatigue and over-enthusiasm are factors to be considered. Furthermore, discrepancies were shown when tests were made of the same patient by the same examiner with audiometers of different manufacturers. Jones has found the audiometer too unreliable in testing bone conduction. For important decisions, such as determining need for operation, he makes three audiometric recordings plus a tuning fork examination. The most useful forks are those with 512, 1024 and 2048 double vibrations. The uncalibrated forks vary considerably. They may be calibrated by being sent to the United States Bureau of Standards. The effort to produce high precision instruments for the testing of hearing has largely been wasted because of mechanical imperfections, variance in human response and in the technic of examination and gross errors in fundamental information. He makes this criticism of the average physician and institution and not of the highly developed acoustic centers with their excellent facilities and most capable staffs.

Based on otologic literature and his own experience, Weersma⁴ gives a detailed discussion of the audiometric types of high tone impairment. These are given as follows: (1) a slight upper tone disturbance encountered with preponderating lower tone deafness, such as is found in many patients with conduction hearing impairment, (2)

³ Jones, M. F. Discussions of Present Methods for Testing Auditory Function, *Ann Otol, Rhin & Laryng* **57** 311 (June) 1948.

⁴ Weersma, P. Audiometric Aspects of Hearing Loss for High Tones, *Nederl tijdschr v geneesk* **85** 3683 (Sept 13) 1941.

a gradual curve indicative of perception deafness, (3) as a "dip," especially at c-5, sometimes also at c-4, and (4) as an abrupt drop at the upper frequencies. The significance of these curves is not yet definitely established, in every case they must be judged in connection with other clinical data.

In this paper, Huizing⁵ calls attention to the fact that in pure perception deafness, audiometric sounds of high intensity are heard with normal loudness. This characteristic, which is called regression, is in contradistinction to the situation in conduction deafness, in which the sensation of loudness is proportional to the hearing loss at all levels. In unilateral deafness, the presence of regression can be detected by means of a modified Weber test, in bilateral perception deafness, it can be inferred if the patient is in the habit of using the radio at an intensity level which is uncomfortable for normal people. The factor of regression complicates to a considerable extent the prescribing of hearing aids. No mention is made in this article of Fowler's work along similar lines.

A paper on hearing tests at the University of Liege, is contributed by Henschel⁶. He states that in contrast to physicians in Anglo-Saxon countries, the study of deafness has interested only a minority of Belgian physicians. He admits that the ideas presented in his paper are far from being recent discoveries but feels that they need to be popularized in his country.

The classic Weber, Schwabach and Rinne test, as well as the tests with whispered voice, watch, monochord and tuning forks, are mentioned and reviewed. The well known difficulties in obtaining satisfactory results with these methods are presented, the two leading ones being that of making rapid group tests and that of obtaining results which can be interpreted quantitatively with precision.

Henschel believes that audiometry has made considerable progress toward solving these questions. For group testing in industry, aviation etc., the phonograph audiometer with standard lists of monosyllabic words transmitted through ear phones has, in his experience, proved to be a valuable means. For pure tones, the Western Electric 6B audiometer[®] is used in the clinic at the University of Liège, it is described in detail. Bone conduction as well as air conduction is tested, and the American type of audiogram is used. The author warns against comparing the results of bone conduction tests made with different oscillators and advises checking the instrument against an "artificial ear" from time to time, as well as being on guard for fluctuations in the current. Graphs illustrating conduction and perception

5 Huizing, H. C. Importance of the Regression Factor in Hearing Tests and Hearing Aids, *Nederl tijdschr v geneesk* **85** 4529 (Dec 6) 1941

6 Henschel, C. Audiometry, *Rev med Liege* **2** 421 (Aug) 1947

deafness are included Allowance for presbycusis is made according to the tables of normal loss for age given by the author

Audiometry is considered especially valuable in the choice of a hearing aid and in the study of deaf-mutism Henschel cites statistics from Sweden and England on the incidence of deafness among children and adults and advises the formation of hearing aid clinics on the order of those established in England

A discussion of audiometry is given by Causse and Gondet⁷ They state that the rapid spread of audiometry, not only in the United States, where it originated, but in Europe, is due to the fact that it provides a more precise means for studying the various forms of deafness than do the classic tests Causse and Gondet use the same decibel notation as that used in this country, but confine themselves to air conduction The remarks include comments on presbycusis, acoustic trauma, otosclerosis and deaf-mutism

In presbycusis the American school has attempted to make an analogy with presbyopia While few audiograms support this view, the changes nevertheless are sufficiently definite to allow a diagnosis in age groups on the basis of loss indicated by the group Knudsen's figures are cited in this connection

Acute or chronic acoustic trauma is an exceptional cause of deafness The former is more likely to be a factor, as exemplified in a case cited by the author, in which deafness occurred as a result of a rocket explosion The audiogram included is characterized by a "trough" involving a band of frequencies in the region of 4096 double vibrations Attention is called to the fact that in chronic acoustic trauma the frequencies involved in the hearing loss do not, as a rule, correspond to those of the etiologic noise The prognosis in acute acoustic trauma should be guarded Some patients may regain their hearing in a large part, while in others, hearing may become stabilized or even grow worse after an initial improvement and give way to a chronic professional deafness

Otosclerosis, in the authors' opinion, can be diagnosed only with probability While the hearing for low tones is chiefly affected, as the disease progresses the hearing for high tones also becomes involved Of interest is a case with rapid progress and pronounced loss of bone conduction in which there was no benefit from an operation by Sour-dille (the patient insisted on the operation) but the hearing level was raised from perception of shouts *ad concham* to conversation at 1 to 1.5 meters by means of the latest American hearing aid

⁷ Causse, R, and Gondet, I Analysis of Audiograms, *Ann d'oto-laryng* 13 193 (May-June) 1946

From a practical viewpoint, the authors consider the study of deaf-mutes to be one of the most important uses of the audiometer, such study enables the otologist to make a prognosis and assist in the training of deaf-mute children. A number of interesting audiograms illustrating the authors' comments are included.

Saltzman and Ersner⁸ present the advantages of masking as an aid in audiometry in children, especially in cases in which a psychoneurotic factor might be involved. They report a case in which audiometric examinations in school and in a clinic produced evidence of severe perceptive deafness in both ears out of proportion to the clinical picture. With masking, however, they were able to get an essential audiogram. The masking apparently alerts the other ear to sounds close to the threshold of hearing by producing a striking contrast effect. After indoctrination in pure tone hearing with masking, a normal audiogram was obtained a week later without masking.

Tests on children below the third grade were found unreliable by Newby⁹. From the third through the eighth grade, of an entire group of 840 ears, 90 per cent showed a difference of 5 decibels or less on a retest. Of 188 ears, 90 per cent showed a variation of 10 decibels between group and individual tests. The group test operated more efficiently as a screening device when a loss of 20 decibels or more for any frequency in either ear was accepted as significant. It saves needless retesting. The group pure tone test as described appears superior to the group speech audiometer as an efficient screening device.

For the eighteen months previous to their article, the authors¹⁰ were faced with the problem of examining a number of young children, many under the age of 6 years, for the purpose of establishing the possible role of deafness in causing backwardness in talking. In some instances the diagnosis lay between deafness and mental backwardness, in no case had quantitative assessment of the hearing been obtained. As it was necessary to establish without delay the kind of special education needed and in view of the fact that many children were brought from a distance, a test procedure was needed which would ensure an accurate measurement of the hearing capacity in the course of a single examination.

Both speech and pure tone tests as ordinarily performed are difficult to apply to children under 6 years. Results of speech tests cannot be expressed in quantitative terms, and the pure tone tests are meaningless

8 Saltzman, M., and Ersner, M. S. Masking as an Aid in Audiometry in Children, *Laryngoscope* **58** 1127 (Oct.) 1948

9 Newby, H. A. Group Pure Tone Hearing Testing in the Public Schools, *J. Speech Disorders* **12** 357 (Dec.) 1947

10 Dix, M. R., and Hallpike, C. S. The Peep-Show. A New Technique for Pure-Tone Audiometry in Young Children, *Brit. M. J.* **2** 719 (Nov. 8) 1947

to a child of this age. For in children with defective hearing pure tone tests are even more unsatisfactory owing to the extreme difficulty of explaining the nature of listening and of hearing. Nevertheless, the advantages of the pure tone audiogram make it essential for examining defective children. This is due to certain fundamental facts bearing on the relation of pure tones to the hearing of speech. This relation is expressed in a diagram of the normal intensity of ordinary speech in terms of decibels, the most important, lying between 1000 and 200 cycles per second, is about 60 decibels above threshold in normal conversation at 3 feet (0.9 meter). Inasmuch as the ready understanding of speech sounds calls for an intensity of at least 20 decibels greater than that at which the sounds can barely be heard, it is evident that a 40 decibel loss of hearing in the central area would give rise to difficulty in understanding conversation and a 60 decibel loss would mean total deafness.

In order to solve their problem, Hallpike and Dix constructed an apparatus for obtaining pure tone audiograms, using the principle of the Pavlov conditioned reflex. The apparatus is composed of two parts, a wooden box, at the back of which is a picture interesting to children, and, screened from the child, a pure tone generator, which is connected with a main transformer in such a manner that when a switch is pulled sound from the loudspeaker and light from a signal bulb (both in the subject's box) are simultaneously emitted. When the child presses another switch near his box, a light illuminates the picture at the back of the box. At first, this maneuver is performed by an assistant seated near the child, in this way the child is taught that a view of the picture may be obtained during a synchronized light and sound combination. Later, the signal bulb is eliminated and sound alone serves to inform him when to illuminate the box, the test then becomes strictly a test of hearing. The pictures are changed for each frequency and the procedure repeated for all frequencies from 4096 to 256 decibels. The test is generally completed in ten to fifteen minutes. Thirty-one children were examined in this manner. Explanatory diagrams and representative case histories are included.

Brown¹¹ has conducted some studies on the reliability of audiometry. He measured the variability of results on the same patient of two different examiners on two different properly calibrated audiometers. The following tests were carried out: (1) variation in two tests with different audiometers and one examiner, (2) variation in tests with the same audiometer and two different examiners, (3) variation in the same subject tested twice by the same examiner with

¹¹ Brown, R. E. G. *Experimental Studies on the Reliability of Audiometry*, J. Laryng & Otol 62:487 (Aug.) 1948.

the same audiometer, and (4) check of threshold calibrations of the two audiometers used. Results showed that differences of plus and minus 15 decibels may occur and should not be taken as an indication that a change in the subject's hearing has taken place. When measurements are repeated on the same system, plus or minus 10 decibels should be required to indicate a change in the subject's hearing. Except in the first test, ambient noise of 40 or 50 decibels did not affect reliability. Practice did not produce any improvement in hearing in any of the group. It was believed that an examiner might become accurate in doing audiometry after testing about 30 subjects.

Kobrak¹² undertakes a physiologic explanation of a cochleovestibular principle of hearing based on phylogenetic conditions. Vestibular tactile perception of individual periods of sound vibrations, especially in the "density" in the succession of individual cycles, in contrast and complementary to the "cochlear proper" sensation of cycle frequency, the physiologic density of the tone, is believed to play a part in the estimation of pitch, in view of their proportional relation.

Kobrak¹³ mentions the great importance of the audiometer and the tuning fork in hearing tests. He stresses the importance of the role played by the tympanic muscles and their ability through hyperactive responses to produce a negative Rinne response in the absence of morphologic changes in the middle ear. When this occurred with typical perceptive deafness, the term physiologic negative Rinne test was used. When the right ear with normal hearing is exposed to the Bárány buzzer at the left ear, most of the Rinne test figures—except the highest—tones become negative. However, there is a fairly quick recovery from the negative results after the exposure to the noise. This tympanic muscle phenomenon must be considered in those cases in which a shortened bone conduction with a negative Rinne result is obtained in the Schwabach and the Rinne test with two or three tuning forks at octave distance. The diagnosis of so-called combined middle and inner ear deafness is usually made without actual awareness of the changes in the middle ear, this factor might be related to the hyperactivity of the tympanic muscles. The early diagnosis of latent deafness depends on special hearing and vestibular tests. Routine audiometry is done, especially with the tuning fork for period hearing, in which the tone is heard briefly over a certain period of the decaying vibration of the tuning fork. This can be considered abnormal only when the period of hearing sensation with 1024 and 2048 double vibrations is less than half the normal and when it is associated with a positive

12 Kobrak, F. Contribution of a Working Hypothesis of a Principle in Cochlear-Vestibular Hearing, *Pract oto-rhino-laryng* 9 346, 1947.

13 Kobrak, F. Some Clinical Phenomena of Deafness in the Light of New and Old Tests of the Ear, *Arch Otolaryng* 47 113 (Feb.) 1948.

audiometric provocative test and abnormal vestibular findings. These various tests spot "mute" areas in the petrous bone. Kobrak states that the term hereditary is used to describe deafness in persons whose next of kin show manifest deafness and the term congenital is applied to deafness in persons in whom latent abnormalities of the genes can be detected by special methods of diagnosis, as discussed in his article. Deafness which cannot be identified as congenital by these methods is placed in the category of acquired deafness, which can be antenatal, intranatal and postnatal.

Luscher and Zwislocki¹⁴ suggest some new tests for hearing. They assert that classic conceptions as to distribution of hearing loss due to conduction and perception deafness no longer hold good. They believe it necessary to supplement routine threshold measurements with new tests. The temporary auditory threshold is determined after the ear is exposed to a stimulus tone of 30 to 80 decibels for four seconds. This causes an almost instantaneous rise in the auditory threshold which increases with the increase of intensity of the stimulating tone. The threshold returns to normal in accordance with an exponential curve. The auditory threshold rises 40 to 45 decibels above normal for a tone of 80 decibels, depending also on the frequency and attaining a maximum at 2000 to 4000 cycles. For persons with normal hearing, the rise of auditory threshold during speech amounts to less than 20 decibels and is of no practical significance.

Howells¹⁵ presents a new and simple technic in the differential diagnosis of type of deafness. He noted, from a series of persons with normal hearing, that in longitudinal stroking of the skin of the neck, beginning at the nape and coming forward, the patient was aware of a point of greatest intensity of hearing of the sound at the anterior border of the sternomastoid muscle, about 1 inch (2.5 cm) below the tip of the mastoid process. Persons with middle ear deafness or normal hearing could locate this point within a few seconds after the test started. Patients with inner ear deafness were unable to detect any sound from stroking the skin. Tests at this point with the bone conduction stimulator of the audiometer showed a trace of bone conduction over the mastoid process at a frequency of about 10 decibels less. Howells attributes the transmission of vibration to simple conduction through the stretched muscle and cranio cochlear conduction from the point of attachment of the sternomastoid muscle.

14 Luscher, E., and Zwislocki, J. The Decay of Sensation and the Remainder of Adaptation After Short Pure-Tone Impulses on the Ear, *Acta oto-laryng* **35** 428, 1948.

15 Howells, D. E. Sound Conduction Through the Sternomastoid Muscle in Middle-Ear and Nerve Deafness, *J. Laryng & Otol* **62** 394 (June) 1948.

The test is offered as a simple differential test between middle ear deafness and nerve deafness

Popa¹⁶ presents a further report on autospirophony, a new method for testing hearing which he first described in 1948. The test is based on the following observations. If one consciously takes notice of nasal respiration when the nose is unobstructed and the hearing normal, there is a sensation as of the respiratory sound's being propagated to the ears by air leaving the nasal orifice. When, however, the auditory meatuses are obstructed lightly by compressing the tragi or, better, with the ends of the fingers, the resonance resembles that of a tube and one has the feeling that the sound is leaving by way of the pharyngeal or nasopharyngeal cavity and not by air through the nasal passages. This sensation exists also when the mouth is open or when respiration is performed with the nasal fossa alone. If, instead of pressing lightly with the fingers, one closes the meatuses lightly, the sensation of the sound's leaving by way of the pharynx is lost and the sound again seems to leave by air through the nasal passages. The phenomenon is similar to that of the Gelle test. If one ear is occluded and the other left free, the respiratory sound is perceived only but the latter through air (intranasal resonance). This experience is analogous to a lateralization of the Weber test to the "healthy" side. The perception of the sound through air leaving the nose and (seemingly) traveling to the ear is called by the author "exoperception", that by intranasal resonance, "intrapercception".

When lateralization in the Weber is to the diseased side, autospirophony is lateralized to that side also. A positive reaction to the Rinne test is characterized by exoperception, and a negative one, to intrapercception of autospirophony. A Gellé test is characterized by the disappearance of autospirophony on strong compression of the external meatus. Bilateral deafness with exoperception is an inner type of deafness, and unilateral deafness with exoperception to the good side also represents an impairment of the inner ear. In acute involvement of the middle ear and in pure conduction deafness due to otosclerosis, autospirophony lateralizes to the diseased side. Popa examined 34 patients with tuning forks and according to the methods outlined in his paper and found that the results obtained with his method were in harmony with those obtained with tuning forks. He considers his method a valuable additional clinical test for hearing impairment.

Bekesy¹⁷ describes a new audiometer, in which the test tone oscillates in the vicinity of the threshold constantly, avoiding fatigue and saving time. The intensity of the tone increases continuously as

16 Popa, N. Autospirophony. A New Method for Testing Hearing, *Ann d'oto-laryng* **64** 463 (Aug-Sept) 1947

17 von Bekesy, G. W. A New Audiometer, *Acta oto-laryng* **35** 411, 1947

long as a signal button is pushed and decreases gradually when the pressure is released. The subject determines his own threshold by pressing the button for perception of tone, releasing it until the tone disappears, in this way the tone oscillates around the subject the whole time. The resulting graph is shown as a series of small waves (similar to those of the electroencephalograph) which follow the same pattern in the same subject on repeated tests. The whole range between 100 and 10,000 cycles per second is covered in fifteen minutes. The masking sound in the nontested ear is alleged not to mask in any way the ear being examined. Comparison of the loudness balance (Fowler's phenomenon) may be observed by the change in the amplitude of the spikes (intensity oscillations). Pathologic conditions (lesions, tinnitus) are suggested by changes in the height of the spikes. To detect malingering, an extra attenuation of 10 decibels is inserted periodically into the circuit. The subject is unable to correct for this, and the graph shows the discrepancy.

PSYCHOGENIC DEAFNESS

Hardy¹⁸ discusses the problems and treatment of psychogenic deafness and emphasizes the fact that the psychogenic factor is commonly an overlay on organic defects of hearing. The diagnostic problem is to measure accurately the relative amount of organic and psychogenic involvement. He feels that this can best be accomplished by the otologist, who is most capable of interpreting the results of hearing tests and evaluating the organic pathologic condition. The essential principle in the technic is repeat testing for both pure tone and speech as well as tuning forks. Special tests are the Lombard, the Stenger and the Doerfler-Stewart, in which superimposed signals of speech and masking noise are employed. All these tests are done to determine a disparate state of affairs. Once this is established, the ratio between psychogenic and organic dysfunction must be determined. Hardy recommends suggestion hypnosis to accomplish this. Such hypnosis can be used by the otologist and is simple and easily mastered without formal instruction. Reference is made to a monograph by Brenman and Gill, *Hypnotherapy: A survey of the literature*, the Menninger Foundation Monograph Series, No. 5, New York, International Universities Press, Inc., 1947. The purpose of suggestion hypnosis is to induce a state of control sufficient to relieve some of the inhibitions of the conscious state while the examiner conducts routine tests of auditory acuity. The so-called waking technic is the simplest form, involving only fixation on a bright object to initiate the patient's response to deep suggestion.

¹⁸ Hardy, W. G. Psychogenic Deafness, *Ann Otol, Rhin & Laryng* 57: 65 (March) 1948.

This results in a kind of hyperconcentration that induces complete relaxation rapidly. A verbal stimulus is necessary, which can be produced through a portable amplification system with head phones. Relatively few patients with a psychogenic overlay on organic deafness are totally deaf for speech. Some persons are resistive to the idea of hypnosis, and it is best to use the terms relaxation and concentration in explaining the procedure. Once the patient is relaxed, a recheck is made for pure tones and speech, and when it has been determined that the hearing threshold is better the clinician has evidence of the relation between the psychogenic and the organic dysfunction. The results under relaxation are indicative of the maximum organic impairment. The key to the therapy is the ability of the patient to gain insight into the relations between the causal factors and the symptoms. The success depends on the patient's willingness and ability to resolve his difficulties. This phase of the treatment can often be more readily accomplished by the otologist than by the psychiatrist. Hardy presents a series of 12 cases with audiograms to illustrate them.

A careful evaluation of the hearing status of the otosclerotic patient to be selected for the fenestration operation should determine how much of the impairment is conductive and how much perceptive in type. This can be done with the use of the tests suggested by Campbell and Macfarlan.¹⁹ A careful audiometric examination for both air and bone conducted sounds is done. Proper masking is essential. It should be measured and raised by decibel steps to just the required amount below the point at which spreading to the opposite, or tested, ear is observed. The ideal method is to use a tone an octave below or even nearer to the tone used in testing. If the hearing is 30 to 40 decibels better in the untested ear, masking for both air and bone conduction should be done. To avoid air-borne sound in bone conduction tests, one should run off a reporting by the patient of levels of loudness at which different pitches are heard when the bone conduction receiver or tuning fork is held in the bone conduction position, as over the region of the mastoid process but not in contact with the bone. Therefore, when the actual bone conduction reading later is the same as that obtained by test for the loudness level, the examiner can appreciate the fact that the hearing for that particular pitch might be for either air conduction or bone conduction. Tuning fork tests for bone conduction hearing can be of great value if the various factors of error are recognized and guarded against. The fatigue test is important, as auditory fatigue does not occur in early otosclerosis or catarrhal deafness, but it does appear in all types of nerve deafness. This test can

¹⁹ Campbell, E. H., and Macfarlan, D. Test Findings Before and After Fenestration of the Labyrinth, *Arch Otolaryng* 47:590 (May) 1948.

be performed by delivering a pitch sufficiently heard at 40 decibels above the patient's hearing threshold for three minutes. The patient's threshold is then retested every thirty seconds.

The Gelle test can also be of value in the hands of an experienced tester. Campbell and Macfarlan state that there can be varying degrees of fixation of the stapes, as they have found a more and more positive response as the disease progressed and suggest a modification of the Gelle test. The butt of the tuning fork is held on the mastoid process and the index finger is used to exert pressure on the column of air between the meatus and the drum membrane. The loudness balance test will give a definite demarcation between operable and inoperable loss of hearing in patients with otosclerosis. The loudness balance test cannot be accomplished if the deafness is of an obstructive type alone but can be if there is nerve deafness. Various degrees of this matching are found as the disease progresses. The speech-hearing tests are important for differentiating deafness, particularly those tests involving articulation interpretation. The authors use the unamplified phonograph with an intensity trimmer on the instrument. This is connected with the microphone outlet of the audiometer which furnishes the necessary amplification and a decibel meter. The patient hears the speech coming from an ear phone, exact threshold readings can be obtained by this method. This threshold test can help differentiate the conductive type of deafness from the perceptive type, as suggested by Walsh and Silverman. In cases of conductive deafness, hearing becomes better with increase in loudness, whereas in the perceptive type, a level is reached at which there is an end of maximum efficiency. Finally, the caloric test is helpful in estimating the functional activity of the mechanism of the inner ear.

At the Central Institute for the Deaf and the department of otolaryngology of Washington University, Thurlow and associates²⁰ studied a group of 161 patients before and after the fenestration operation. Statistical analysis was planned to answer questions as to the reliability of the various tests, whether the patient's familiarity with the tests improved his performance, whether one test could be substituted for another and the value of the tests for predicting improvement of hearing by fenestration. After utilization of a relatively large battery of tests, it was found that only the following ones were necessary: pure tone audiometry by air and bone conduction, threshold of detectability of speech, threshold of speech for Western Electric 4C recordings and Psycho-acoustic Laboratory test no. 9 and 12 and P-B word

²⁰ Thurlow, W. R., Silverman, S. H., Davis, H., and Walsh, T. E. A Statistical Study of Auditory Tests in Relation to the Fenestration Operation. *Laryngoscope* 58:43 (Jan.) 1948.

lists given at several intensities. The authors' statistical analysis of these tests showed that test no 9, spondaic words, and test no 12, sentences, have a standard error of measurement of about 4 decibels, which is about the same as for pure tone audiometry. All the speech lists mentioned revealed losses so closely correlated with one another that only one of them need be used in any clinical routine. The prediction of the thresholds for speech from the losses for pure tones averaged over the speech range is less satisfactory than the prediction from one speech test to another. Patients with conduction deafness show a better discrimination for speech measured by the articulation scores obtained on word lists given at high intensity than do patients with a significant amount of nerve deafness. Patients with predominantly conductive deafness give the best results on tests made within eight months after the fenestration operation. None of the tests employed showed any great predictive value. The average gain for speech in this period was about 14 decibels. The average gain for pure tones in the speech range was about 9 decibels. Pure tone audiometry significantly underestimated the gain for speech. Reduction in the degree of exenteration of the mastoid cells produced no detectable change in the average gain, and the use of the cartilage stopple gave about 8 decibels less immediate gain for speech and in many cases did not prevent subsequent closure. Details including correlation coefficients and statistical tests of significance are included in the paper.

Juers²¹ stresses the importance of the Weber test in postoperative evaluation of cochlear function in cases of fenestration. In 88 consecutive cases in which there was no definite lateralization before operation, in the Weber test lateralization to the ear operated on occurred in 51, and in the remaining, except for a few, no lateralization occurred. The packing in the ear was not a significant factor, as similar results were obtained in a similar group checked at a later interval when no packing was present. In general, in those cases in which there was a shift to the untreated ear several days after operation after lateralization to the side operated on, initial gain in hearing was less. Bone conduction determinations made at the third postoperative month for the frequencies from 256 through 2048 showed an improvement ranging from 1 decibel for the lower frequency to 13 decibels for the higher frequency in the ear operated on. Juers discusses the physiology of the fenestrated ear and presents some evidence that air-conducted sound may enter the inner ear chiefly by passing directly through the fenestra.

21 Juers, A. L. Observations on Bone Conduction in Fenestration Cases, *Ann Otol, Rhin & Laryng* **57** 25 (March) 1948

Reid²² presents a statistical study of "permanent" deafness in artillery personnel and medical students used as controls. The deafness may be abrupt or gradual in onset and in either case may result from one severe blast or from long-continued exposure to less severe stimuli, more frequently the latter.

Woods²³ believes that in otosclerosis loss by bone conduction is early, beginning in the higher tones. Bone conduction remains normal at 256 double vibrations for a long time, even when it is grossly reduced for 512 and higher frequencies. Loss by air conduction begins in the lower tones. In successful cases after fenestration, improvement in bone conduction as well as air conduction takes place. Woods advances several possible explanations. He uses the Western Electric 2B audiometer, with the D-80904 bone conduction receiver. [REVIEWER'S COMMENT: Bone conduction as measured on the audiometer is not fully accepted by acoustic physicists.]

Collins²⁴ reports his experience with aural trauma caused by gunfire. In the series, 108 patients were tested, all but 3 experienced deafness at the time of injury. In 3 the onset was delayed or gradual. Tinnitus occurred in 88 per cent, pain at the time of injury in 37 per cent, bleeding in 29 per cent, discharge in 15 per cent, ruptured membrana tympani in 50 per cent and disturbed labyrinthine function in 75 per cent. Of the abnormal reactions, unilateral paresis of the ear canal occurred in 21 per cent and bilateral paresis in 7 per cent, 56 per cent of the patients showed directional preponderance. The figures on mixed reactions were very small. Vertigo occurred in 50 per cent, nausea in 15 per cent, headache in 25 per cent and vomiting in 7 per cent. In this series, a tonal dip at the frequency of 4096 double vibrations was present in only 5 patients.

Friedman²⁵ reports his observations on 100 patients with acoustic trauma admitted to a general hospital in the first six months after the invasion of the European Continent. The characteristic audiometric findings were a dip at or near the frequency of 4096 double vibrations, with a minimal loss, and a deepening and broadening of the curve in the frequencies above 2048 cycles, at which there was greater damage. There was also a slight depression of the curve in the frequencies

22 Reid, G. "Permanent" Deafness Due to Gunfire, *J Laryng & Otol* **62** 76 (Feb.) 1948.

23 Woods, R. H. Some Observations on Bone Conduction Following the Fenestration Operation, *J Laryng & Otol* **61** 22 (Jan.) 1948.

24 Collins, E. G. Aural Trauma Caused by Gunfire, *J Laryng & Otol* **62** 358 (June) 1948.

25 Friedman, O. Blast Injuries of the Ears, *Arch Otolaryng* **47** 471 (April) 1948.

curve at 2896 and 4096 double vibrations associated with a rise in the higher tones was found in 32 cases, or 42 per cent. This was not associated with age. It resembled the dip frequently present after exposure to trauma or gunfire. The authors are of the opinion that possibly hypertension produces a similar traumatic effect on the cochlea as that of trauma, and association of this type of hearing loss with a history of trauma from noise should suggest the possibility of hypertension.

HEARING AIDS ACCEPTED BY THE COUNCIL ON PHYSICAL MEDICINE OF THE AMERICAN MEDICAL ASSOCIATION

As of December 1, 1948

Acousticon Model A 100 MFR. DICTOGRAPH PRODUCTS CORP 580 Fifth Avenue, New York 19	J A M A 138 293 (Sept 25) 1948
Aurex (Semi portable)	J A M A 109 585 (Aug 21) 1937
Aurex Model C B and Model C A	J A M A 120 535 (Oct 17) 1942
Aurex Model F	J A M A 138 294 (Sept 25) 1948
Aurex Model H MFR AUREX CORP 1117 North Franklin Street, Chicago	J A M A 136 1099 (April 24) 1948
Beltone Mono Pac	J A M A 130 637 (March 9) 1946
Beltone Harmony Mono Pac MFR BELTONE HEARING AID CO 1450 West Nineteenth Street, Chicago	J A M A 133 543 (Feb 22) 1947
Dysonic Hearing Aid, Model 1 MFR DYNAMIC HEARING AIDS, INC 1042 Atlantic Avenue, Brooklyn 16	J A M A 137 1534 (Aug 21) 1948
Electroear Model C MFR AMERICAN EARPHONE CO, INC 10 East Forty Third Street, New York 17	J A M A 136 769 (March 13) 1948
Gem Hearing Aid Model V 35 MFR GEM EAR PHONE CO, INC 50 West Twenty Ninth Street, New York 1	Report not yet published
Maico Type K	J A M A 129 32 (Sept 1) 1945
Maico Atomer MFR MAICO CO, INC North Third Street, Minneapolis	J A M A 133 542 (Feb 22) 1947
Mears Aurophone Model 200	J A M A 138 428 (Oct 9) 1948
1947 Mears Aurophone Model 98 MFR MEARS RADIO HEARING DEVICE CORP 1 West Thirty Fourth Street, New York 1	J A M A 137 1535 (Aug 21) 1948
Micronic Model 101 (Magnetic Receiver) MFR MICRONIC CO 727 Atlantic Avenue, Boston 11	Report not yet published
Microtone T 3 Audiomatic	Report not yet published
Microtone T-4 Audiomatic	J A M A 136 109 (Jan 10) 1948
Microtone T 5 Audiomatic MFR MICROTONE CO 4602 Nicollet Avenue, Minneapolis 9	Report not yet published
National Cub Model	J A M A 138 295 (Sept 25) 1948
National Standard Model	J A M A 138 295 (Sept 25) 1948
National Star Model MFR NATIONAL HEARING AID LABORATORIES 815 South Hill Street, Los Angeles 14	J A M A 138 295 (Sept 25) 1948
Otarion, Model A 1	J A M A 115 1101 (Sept 28) 1940
Otarion, Model A 3	J A M A 132 1071 (Dec 28) 1946
Otarion, Model A 4 J & S	J A M A 132 925 (Dec 14) 1946
Otarion, Model E 1	J A M A 136 108 (Jan 10) 1948
Otarion, Model E 1 S	J A M A 138 650 (Oct 30) 1948
Otarion, Model E 2 MFR OTARION HEARING AIDS 159 North Dearborn Street, Chicago	J A M A 138 887 (Nov 20) 1948
Paravox Models VH and VL	J A M A 132 79 (Sept 14) 1946
Paravox Model XT	J A M A 134 365 (May 24) 1947
Paravox Model XTS MFR PARAVOX, INC 2056 East Fourth Street, Cleveland 15	J A M A 136 109 (Jan. 10) 1948

Precision Table Hearing Aid MFR PRECISION ELECTRONICS CO 850 West Oakdale Avenue, Chicago 14	Report not yet published
Radioear Model 45 CM	J A M A 126 1151 (Dec 30) 1944
Radioear Model 45 M magnetic air conduction receiver	J A M A 127 219 (Jan 27) 1945
Radioear Model 45 M magnetic bone conduction receiver	J A M A 127 27 (Jan 6) 1945
MFR E A MYLRS & SONS 306 Beverly Road, Mount Lebanon, Pittsburgh	
Ravox (Semi Portable) MFR ZENITH RADIO CORP 6001 West Dickens Avenue, Chicago	J A M A 113 18 (Oct 28) 1939
Silver Meronic Hearing Aid Model 101 MFR MICRONIO CO 727 Atlantic Avenue, Boston 11	J A M A 135 159 (Sept 20) 1947
Solopak Hearing Aids MFR ALLEN HOWE ELECTRONICS CORP Salem, Mass	J A M A 136 763 (March 13) 1948
Sonotone Audicles Nos 530, 531 and 533	J A M A 123 837 (Nov 27) 1943
Sonotone Model 600	J A M A 131 523 (June 8) 1946
Sonotone Model 700	J A M A 135 838 (Nov 29) 1947
Sonotone Model 900	Report not yet published
MFR SONOTONE CORP Elmsford, N Y	
Superfonic Hearing Aid MFR AMERICAN SOUND PRODUCTS, INC 2454 South Michigan Avenue, Chicago	J A M A 138 293 (Sept 25) 1948
Telex Model 22	J A M A 134 605 (June 14) 1947
Telex Model 97	J A M A 138 291 (Sept 25) 1948
Telex Model 612	J A M A 114 1634 (April 27) 1940
Telex Model 900	J A M A 117 1978 (Dec 6) 1941
Telex Model 1020	J A M A 117 2072 (Dec 18) 1941
Telex Model 1350	J A M A 126 705 (Nov 11) 1944
MFR TELEX, INC Minneapolis 1	
Trimm Vacuum Tube Model 300 MFR TRIMM, INC 400 West Lake Street, Libertyville, Ill	J A M A 133 542 (Feb 22) 1947
Unex Model "A" MFR NICHOLS & CLARK Hathorne, Mass	J A M A 134 254 (May 17) 1947
Vactuphone Model 3 MFR ALLEN HOWE ELECTRONICS CORP Salem, Mass	J A M A 136 769 (March 13) 1948
Western Electric Ortho tronic Model	J A M A 121 1283 (April 17) 1943
Western Electric Model 63	J A M A 131 895 (July 13) 1946
Western Electric Model 64	J A M A 134 605 (June 14) 1947
Western Electric Models 65 & 66	J A M A 137 534 (June 5) 1948
MFR WESTERN ELECTRIC CO, INC 120 Broadway, New York 5	
Zenith Radionic Model A 2 A	J A M A 127 159 (Jan 20) 1945
Zenith Radionic Model A 3 A	J A M A 127 159 (Jan 20) 1945
Zenith Radionic Model B 3 A	J A M A 127 158 (Jan 20) 1945
Zenith Model 75	J A M A 135 773 (Nov 22) 1947
MFR ZENITH RADIO CORP 6001 Dickens Avenue, Chicago	

All the hearing devices listed in this report employ vacuum tubes

AUDIOMETERS ACCEPTED

ADC Audiometer Model 50 MFR AUDIO DEVELOPMENT CO 2833 Thirteenth Avenue South, Minneapolis	J A M A 137 1131 (July 24) 1948
Maico Audiometer Model D-5	J A M A 114 139 (Jan 13) 1940
Maico Audiometer Model D 8	J A M A 120 205 (Sept 19) 1942
Maico Audiometer Model D 9	Report not yet published
Maico Model RS Group Phonographic Audiometer MFR MAICO CO, INC North Third Street, Minneapolis	J A M A 137 1535 (Aug 21) 1948
Sonotone Audiometer, Model 20 MFR SONOTONE CORP Elmsford, N Y	J A M A 124 94 (Jan 8) 1944
Western Electric Audiometer, Model 4 C	J A M A 118 1297 (April 11) 1942
Western Electric Audiometer, Model 6 BP MFR WESTERN ELECTRIC CO, INC 120 Broadway, New York 5	J A M A 114 1634 (April 27) 1940

HEARING AIDS

The results of audiometric examination of a person with an artificial drum membrane are reported by Aubry²⁸ The patient, aged 62, had considerable impairment of hearing in the left ear Hearing in the right ear was better, but there were a large posteroinferior perforation in the drum membrane and a slight discharge With treatment the ear became dry, and trial of an artificial membrane showed considerable improvement in hearing Both bone and air conduction were studied with the membrane in place By air conduction, improvement was as follows 128 double vibrations, 20 decibels, 256 double vibrations, 18 decibels, 512 double vibrations, 18 decibels, 1024 double vibrations, 18 decibels, 2048 double vibrations, 14 decibels, 4096 double vibrations, 2 decibels, and 8192 double vibrations, 0 decibels Bone conduction showed improvement only for 512 double vibrations, with a gain of 4 decibels, for 1024 double vibrations, with a gain of 6 decibels, and for 2048 double vibrations, with a gain of 2 decibels Hearing of the whispered voice improved from 0.25 meter to 2 meters

Aubry states that these observations are contrary to those of the older writers and in accord with those of Nasieff and Causse in showing that the low tones are benefited more than the high tones by the use of an artificial membrane, bone conduction is not improved with its use

In this article, Macfarlan²⁹ again stresses the importance of speech hearing and its testing The formulas used for computing hearing loss for speech from the pure tone audiogram are not accurate The best way to test speech hearing is with speech as a testing stimulus The instrument needed is a phonograph with a motor-driven turntable and a crystal pick-up Within the box are amplifying tubes, and on the front panel is an intensity or loudness attenuator marked in decibels, with a zero setting regulated by a "trimmer" A head phone for individual testing and a loudspeaker for testing the efficiency of hearing aids are used The record, the most important item, has monosyllabic words on one side and numbers on the other The patient is directed to repeat the words he hears at a point easily audible, and the loudness of the speech is attenuated to the threshold of hearing A reference point should be established to correlate speech work with audiometer decibel level The frequency of 1000 cycles is the commonest reference frequency used in acoustic work This is in the middle of the zone of both speech frequencies and greatest hearing acuity The 1000 cycle note of the phonograph is matched to the 1000 frequency note of the

28 Aubry, M. An Artificial Tympanic Membrane Studied by Audiometry. New Case, *Ann d'oto-laryng* **64** 167 (March-April) 1947

29 Macfarlan, D. Testing Speech-Hearing and the Efficiency of Hearing Aids. *Ann Otol, Rhin & Laryng* **57** 444 (June) 1948

audiometer at various loudness (decibel) levels. This is done by playing a record of a 1000 cycle note through the equipment and sending it out over a phone which is identical to the phone of the frequency audiometer used for comparison.

Long experience with speech-hearing tests has brought out the following facts. The response to numbers is usually 10 decibels lower than to other monosyllabic words, thresholds are as sharp as with frequency audiometry, the personal equation error is rarely more than 5 decibels. Patients can reach lower thresholds in going from audible to inaudible than in going from inaudible to audible, and thresholds are sharper in persons with nerve deafness than in those with catarrhal deafness. Auditory inattention in senile deafness and in profound deafness of long standing can easily be demonstrated by comparing the intensity required for the first response with the accurate lower one obtained after the ear has accustomed itself to hearing. Hearing for vowel sounds is usually much better than for consonants. Tests should be made for the convenient loudness level, the pain threshold should also be investigated because it will be difficult to get the patient to accept a hearing aid that gives the needed amplification if the pain threshold is close to the auditory threshold. In testing the relative efficiency of aids, the loudspeaker is used and the patient is placed at a fixed distance from the instrument, he adjusts the aid to obtain its greatest efficiency, while the otologist adjusts the intensity to the patient's best threshold. The patient can try various aids at the retailers and can bring for testing those which seem to be most suitable. This would make it unnecessary for the otologist to have a stock of aids on hand for testing. Speech-hearing determination is essential for proper testing, for follow-up treatment, for legally rating disability, for selection of a proper aid and for professional guidance and advice. The threshold audiogram alone is not an adequate measure of impaired hearing.

Berry³⁰ reviews the recent literature on hearing aids. There has been a sharp advance in the production and use of aids since the war. In 1943 only 110,000 hearing aids were in use, in 1946, 225,000 were purchased, and it is estimated that now 800,000 are in use. They are being used to advantage by the very young when the child is learning speech, by those of school age with lip reading and by those in later life who have severe and advanced impairment. The value of auricular training was definitely brought out during the war, and this training should be carried out in civilian life. The statement is made in the Harvard report, which is here mentioned, that uniform amplification of

³⁰ Berry, G. Hearing Aids, *Ann Otol, Rhin & Laryng* 57: 500 (June) 1948.

hearing aids, with possible moderate emphasis on the higher frequencies, is better than selective amplification. Reports from the engineers of the different companies point out the many recent advances in the instruments. Batteries are now smaller and more efficient, transmitters are now in one piece, ethyl cellulose is used for the case of the instrument, butyl rubber mountings are used for insulation and smaller and moisture-proof cords reduce noises produced by the rubbing of clothes. Smaller and perfected midget vacuum tubes are more powerful and free from objectionable resistance noise, ear receivers are smaller and more efficient. Plastics used in making ear molds have been so improved that now the molds can be safely made, provided that any obstructing wax has first been removed. Introduction of the "printed circuit" in the production of aid by manufacturers will save much skilled labor in small part assembly and makes for ruggedness, protection against moisture and simplicity. Some companies are now using it with enthusiasm. Continued advances seem assured in view of the healthy and keen competition in the industry.

Pothoven³¹ discusses modern hearing aid for Dutch readers. A description of the parts of the tube apparatus and of the method of fitting, with high praise for American instruments and their control by the Council on Physical Medicine and Rehabilitation of the American Medical Association, forms the main portion of the article. The author cites the work of Fowler on recruitment and states that this factor necessitates an automatic volume control for certain patients, as otherwise irreparable damage may be done to the hearing organ.

An excellent survey of the development and principles involved in the operation and choice of hearing aids is given by Segal³², the language used is simple and nontechnical.

The elements of both carbon and valve aids are adequately described. The drawbacks of the carbon hearing aid were weak performance on high tones and restricted frequency range. The author states that in England it has been completely superseded by the valve instrument, which is greatly superior. Cases are reported by reliable authorities in which patients with losses as high as 95 per cent in the frequency range 1024 to 2048 have been enabled to follow normal speech at a distance of several feet.

The essential parts of a modern aid are listed as (a) a microphone for receiving sound and converting it into electrical energy in the shape of impulses which reproduce the rise and fall in the pitch and level of the sound, (b) an amplifier unit, made up of a system of valves

31 Pothoven, W. J. Modern Hearing Aids, *Nederl tijdschr v geneesk* 91 1242 (May 17) 1947

32 Segal, Z. W. Hearing Aids, *Acta oto-laryng orient* 3 20, 1947

which magnify these electrical impulses, (c) dry batteries, which supply the necessary power to the amplifier unit, and (d) the ear piece, which receives the magnified electrical impulses and reconverts them to sound

A detailed description of each part is given. The double ear piece favored by Knudsen is described. This ear piece delivers the entire band of frequencies to one ear, while the other ear receives only frequencies higher than 1000 cycles, this is supposed to prevent masking. Nonportable aids, notably those which combine a hearing aid and radio set, are also described.

In another paper, Pothoven³³ relates his experience with modern hearing aids. The fitting of hearing aids is largely in the hands of the laity. It should be in medical hands because it is possible to damage the patient's hearing, especially in cases with recruitment, by injudicious fitting. The shortcomings of bone conduction equipment have reduced their usefulness to about 10 per cent of cases. A carefully fitted ear piece is important. To avoid damage to hearing in cases of deafness with recruitment, special devices, such as peak clipping or compression amplification, are necessary. A hearing aid should be delivered to the patient on a medical prescription in writing giving the necessary details, a very high percentage of Segal's patients got the best results with an aid giving a flat response in the speech range (512, 1024 and 2048) or with an aid giving slight emphasis on the higher frequencies. These results are in accord with those of experiments of Davis and Stevens, described in their book on hearing aids. Segal believes that in the future only a few types of hearing aids will be found necessary. Recruitment is the most important factor to consider in fitting hearing aids, in order to avert possible damage to the patient's own hearing function.

REHABILITATION

Fisher and associates³⁴ report on the work done by the newly created special hearing clinic of the Medical College of Alabama, at the Jefferson-Hillman Hospitals. During the past two years 647 children were examined, and 211 of them were found to have a definite hearing loss. A careful history, an examination of the ear, nose, and throat, including the use of the nasopharyngoscope and examination of the hearing, was obtained for all the patients. A special sound room, precision audiometer and tuning forks were used for evaluation. Of the 211 cases of impaired hearing, 83 were due to obstruction of the eustachian tubes by lymphoid tissue, and the hearing was restored to

³³ Pothoven, W. J. Some Aspects of Modern Hearing Aids and Their Fitting, *Acta oto-laryng* **36** 296, 1948.

³⁴ Fisher, G. E., Moody, F. S., Hicks, J. J., and Brannon, W. H. The Program of the "Better Hearing Clinic" at the Medical College of Alabama, *Eye, Ear, Nose & Throat Monthly* **27** 553 (Dec.) 1948.

normal by proper therapy. In 53 additional cases therapy was in progress. Of the 83 patients 56 had tonsillectomy and adenoidectomy alone, 1 had adenoidectomy alone, 11 had tonsillectomy and adenoidectomy plus one radium treatment, 2 had two radium treatments, and 2 had three treatments. Normal hearing was restored within three months following the last radium treatment in the majority of cases, the largest number of restorations occurring within one month. The authors make a plea that careful examination be made early on children to prevent a permanent loss in hearing in those amenable to therapy.

Lacerda and Ver Loet³⁵ report a research audiometric study of the residual hearing of the pupils of the Rio de Janeiro National Institute for the Deaf. A Western Electric 6A audiometer® was used with a Pilling-Witting auditory masker in a soundproof room. Two hundred audiograms were used in an examination of 141 children 7 years of age or older. In all cases in which a total loss of hearing by air conduction was observed, tests of hearing by bone conduction also gave negative results. In only 5 audiograms, 2.5 per cent, was a total loss for all frequencies for air and bone conduction noted. The report is made for two thresholds, the first quartile expressing the auditory threshold of 25 per cent of the ears which heard best and the median expressing the auditory threshold of 50 per cent of the ears with the best hearing. In the first quartile, 25 per cent or more perceived all the frequencies except 8192 by air conduction, and only 25 per cent heard only the 256 and 512 frequencies by bone conduction. Similarly, in the median group the same air and bone conduction were perceived by less than 50 per cent. The losses were about the same in the two ears. The quartile thresholds for air conduction had a somewhat wider frequency range and were at more convenient levels than the median—namely, 128 to 4096 cycles as compared with 256 to 2048 cycles. Bone conduction was alike for the two, ranging from 256 to 512 cycles, though at different levels. There was an abrupt change with greater loss starting at 2048 cycles by air conduction and 512 cycles by bone conduction. These results conform to the picture of nerve or perception deafness. Seventy per cent of the group on whom reports were available were born deaf, and 30 per cent acquired the impairment after birth. Of the congenital or constitutional lesions causing deafness in the 70 per cent who were born deaf, syphilis ranked first (36 per cent), followed by hereditary deaf-mutism (7.5 per cent) and alcoholism (3 per cent), the cause was obscure in 23.5 per cent. Among the 30 per cent with acquired deafness, the condition was due to injury

35 Lacerda, A. P., and Ver Loet, A. E. Audiometric Studies of the Residual Hearing of Pupils of Rio de Janeiro National Institute for the Deaf, *Arch Otolaryng* 47: 239 (March) 1948.

to the head in 7 per cent, to various forms of meningitis in 5 per cent, to epidemic cerebral meningitis in 4 per cent and to various other diseases in 4.5 per cent, the cause was obscure in 4 per cent. Audiograms in the two groups varied insignificantly. There is apparently no association between auditory thresholds and causes of deafness.

Audiometric tests of bone conduction hearing in deaf children produce results falling into three groups: (1) no response, (2) response at some frequencies, mainly 256 and 512, and (3) responses indicating perception of such slight and transitory nature that recording is impossible. Responses of the last type are termed "vanishing perception." This "vanishing perception" of the auditory tone occurs more frequently for bone conduction, but it also occurs for air conduction at high intensity levels of short duration. It lasts only a few seconds, with a silent period succeeding each of its appearances until there are no more responses. It is very inconstant and variable, making recording of it impossible. One can test for "vanishing perception" by using the regular bone conduction receiver and raising the intensity gradually. When the fleeting response is obtained, the intensity is increased to make sure that no more hearing is present. The test is repeated to see whether the phenomenon recurs. Another way to test for this is to switch to another frequency after it occurs, leaving the intensity at the same point, and then switching back to the original frequency to see if it recurs again. This same phenomenon was also observed in adults with severe cochlear or nerve impairment. This phenomenon occurred in 39 per cent of the children tested by bone conduction, in 4.5 per cent tested by air conduction and in 4 per cent tested by both. It reappears at a different frequency oftener than at the same one at subsequent tests. It differs from physiologic fatigue, which is binaural in nature, by being frequently present in a single ear. The authors maintain that this phenomenon is significant of severe and advanced cochlear damage observed in persons with advanced perceptive deafness, particularly in deaf-mutes. From the acoustic standpoint, vanishing perception is associated with a lack of sufficient intensity to support a steady sensation. From the physiologic and pathologic point of view, it is related either to a very weak excitation of the hair cells of the organ of Corti or to a slight conduction of a nerve stimulus. Anatomically, it is associated with the development of a degenerative process involving both the nerve and the sensory organs.

Klotz and Tissue³⁶ make a plea for group testing in French communities in order to facilitate the prevention of deafness and the rehabilitation of the hard of hearing. American statistics as to the

³⁶ Klotz, P. L., and Tissue, M. Uncovering Auditory Deficiency in the Community, *Arch med sociale* **111** 446 (Oct) 1947.

number of persons handicapped by hearing defects are cited in support of this plea

The authors trace the development of the audiometer, which they consider the ideal instrument for testing of hearing, from the telephonic acumeter devised by Hartman in 1878 to the modern instrument which resulted from the researches of Bunch, Fowler and Wegel. The usual instructions for operating an audiometer are given. Mention is made of the suggestion of Hughson and Thompson for employing a loud-speaker and of Bloomer's method (picture association) for testing children. The value of the audiometer in testing deaf-mutes and malingerers is stressed. [REVIEWER'S NOTE. The value of the pure tone audiometer in detecting simulation is limited.]

The value of the phonograph audiometer in testing the ability to hear speech is also stressed. Klotz and Tissue cite the recent work of J. Donald Harris showing that the results with the phonograph audiometer show a variation of less than 5 decibels, compared with those obtained with the pure tone audiometer. The phonograph audiometer is especially valuable for rapid testing of groups in schools, factories, military establishments, etc. It is also of value in controlling the efficiency of hearing aids.

The recent methods of Schilling and Harris for group testing of pure tones by means of multiple receivers are also cited. The authors conclude that audiometry should have a leading role in social medicine.

Macfarlan³⁷ discusses the problem of proper handling of the severely deaf child between the ages of 2 and 6 years. The first thing that is recognized usually is the child's failure to speak rather than the deafness. Most of these children have some residual usable hearing which requires arousing and awakening by amplified sound now available. The principal problem is to determine the usable hearing by proper testing. A program of training in a conditioned reflex must be started, the simplest response being the raising of the hand when a loud sound is either heard or felt. This training can be done with an electric buzzer operating a telephone receiver. The parents are given this equipment, and the conditioned response is practiced by the child and developed at home. After this reflex is developed, the child can be tested for pure tones in the speech range. Many of these children show as much as 50 to 60 per cent hearing in the speech hearing zone. A hearing aid can then be used and a definite program of word, phrase and sentence teaching started. Later, lip reading is permitted and encouraged to supplement hearing. The physician should also see that tubal catarrh, adenoid hyperplasia and colds in the head are properly

37 Macfarlan, D. Problem of the Congenitally Deaf Child, *J. A. M. A.* 137:774 (June 26) 1948.

treated Macfarlan found that approximately 90 per cent of a series of 50 patients had usable hearing. Vestibular tests and ear mold impressions should be made preferably while the patient is under light anesthesia. This program is essential to prepare these children to enter a school for children with normal hearing and thus escape institutionalization if possible. The physician should follow and supervise these patients to see that the program is properly carried out. [REVIEWER'S COMMENT Clinics and classes for parents of children of this preschool group are being held now in many places to acquaint them with the proper handling and training of their children.]

Kinney³⁸ studied the relation of loss of speech to total deafness due to meningitis in 29 cases. He observed that loss of speech follows a fairly definite pattern. When a person with normal hearing and speech becomes totally deaf, he tends to lose his speech to an extent directly proportional to the length of time that he had speech. Speech training must be started at once, especially in younger patients, because their memory patterns are not firmly established.

Kinkade³⁹ reviews the literature on lip reading over a period of ten years and presents his analysis and views on this subject. He states that lip reading is an integral part of otologic therapy and should be the first step in a program of rehabilitation for the acoustically handicapped. When proper hearing clinics giving this service are not available, the otologist should refer the patient to a competent lip reading instructor or school. Supervision of the patient's first steps in lip reading can be incorporated into private otologic practice. Lip reading is indicated in all cases of chronic or progressive acoustic impairment entailing a considerable hearing loss within the speech range. It should be started immediately after the diagnosis is made to be beneficial to the patient psychologically as well as to the progress of medical therapy. Whenever possible, it should be started early in preschool age.

25 East Washington Street

38 Kinney, C. E. Loss of Speech Due to Meningitic Deafness, *Arch Otolaryng* **47** 303 (March) 1948.

39 Kinkade, J. M. Lipreading for the Deaf and Hard of Hearing. Its Place in Otologic Therapy, *Laryngoscope* **48** 118 (Feb) 1948.

Abstracts from Current Literature

Ear

AURICULO-MASTOID TUBE PEDICLE FOR OTOPLASTY D N STEFANOFF, Plast & Reconstruct Surg 3 352 (May) 1948

An excellent description, photographs and sketches, including the casts of a deformed ear and the steps in its correction, are presented by the author. He gives a detailed step by step operative procedure of the reconstructed auricle.

He presents the following summary: A case of partial auricular restoration for loss of the middle third of the auricle, involving the helix and the concha, is presented. The formation and utilization of an auriculomastoid tube pedicle are described. The cartilaginous support was restored by preserved homogenous cartilage, while the soft tissues were restored by a postauricular flap. The helix was restored by partial spreading of an auriculomastoid tube pedicle. The patient had pronounced hypertrichosis, involving not only the trunk but the supraclavicular and postauricular areas as well, so that the operator was deprived of the usual donor sites for the formation of a tube pedicle. The auricular restoration was completed in eight surgical procedures in a five month period. The anatomic nomenclature auriculomastoid tube pedicle localizes the donor site of this type of pedicle.

SELTZER, Philadelphia

THE PRESENT STATUS OF THE FENESTRATION OPERATION MORRISSET SMITH, New York State J Med 49 69 (Jan 1) 1949

This resume was read before the annual meeting of the New York State Medical Society, in New York, May 21, 1948. Window resection is primarily for conduction deafness, not for severe eighth nerve degeneration. In the early stage of deafness, neither bone nor nerve is much impaired. Most cases are "mixed", that is, there is partial involvement of the middle ear and the inner ear. This is "the ideal time" for fenestration. The operation is not limited to patients who have otosclerosis or to persons who have never had infections of the middle ear or the mastoid process. The primary requisite is a functioning auditory nerve, partially but not severely impaired. Preoperative care calls for sedation with pentobarbital sodium, butethal (neonal®) or meperidine hydrochloride (demerol hydrochloride®), supplemented during the operation, if necessary. Morphine must be avoided because of depression of the respiratory center. Good technic should require two hours or less. Regeneration of bone is still the *bête noire*, but it is possible to do a revision with success. A serious degeneration of the eighth nerve contraindicates fenestration, since deafness may increase. There are two very important factors in technic. 1 The field must be flushed with sodium chloride solution very frequently, and careful suction applied now and then. All bone chips must be removed. 2 There must be perfect outlining of the three canals, removal of all gutter cells and freeing of the facial ridge. Removal of the cells of the mastoid process, total or partial, is still *sub judice*. The procedure is "practically free from danger other than the minimum risk incurred in any major surgical operation. hearing [may be] successfully restored in a good percentage of cases."

VOORHEES, New York

EUSTACHIAN TUBE IRRADIATION EDMUND P FOWLER JR, New York State
J Med 49 187 (Jan 15) 1949

Fowler has been an ardent advocate of radium in discussing the treatment of barotrauma of aviators. However, he says that any one using it for alleviation of deafness (other than that due to lymphoid obstruction) will be disappointed. Radium does improve the function of the eustachian tube at the orifice, but it does not replace surgical removal of obstructions. It will not "dissolve adhesions." Moreover, virus types of otitis are not relieved by radium. He recommends that 50 mg monel metal capsules be applied for eight or nine minutes (the application not to be repeated under three weeks). While he knows of no radium burns or blood cytopenia, Fowler thinks some users are careless in handling radium. It works silently and without immediate untoward symptoms, therefore, it is well to have at hand a competent physicist who will emphasize the necessary precautions to all personnel. A secretary locked up two 50 mg capsules in her desk for two days "less than two feet away from her ovaries." The result is unreported, but it is cited as an example of carelessness. "previous irradiation may sensitize tissue to further irradiation and even to infection, particularly if large doses are used." Irradiation of the nasopharynx at the tubal orifices is a "useful modality," but its cumulative effect must be remembered and governed accordingly.

VOORHEES, New York

THE TYMPANIC PLEXUS G PORTMANN and E PUIG, Rev de laryng 70.1
(Jan-Feb) 1949

The tympanic plexus is formed by sensory and autonomic nerve fibers. Anatomically, the relations between the autonomic fibers of the tympanic plexus and the autonomic fiber system of the labyrinth are limited.

Three autonomic ganglions annexed to the cranial nerves, each containing sensory, sympathetic and parasympathetic fibers, give afferent fibers to the tympanic plexus. They are the sphenopalatine ganglion, the otic ganglion and the ophthalmic ganglion.

The sphenopalatine ganglion, with the vidian nerve (the canalis pterygoidei), has a parasympathetic root originating in the lacrimal nucleus adnexed to the nucleus of the facial nerve. The parasympathetic fibers follow the facial nerve until the geniculate ganglion is reached, then the large superficial petrosal nerve. The sympathetic root of the sphenopalatine ganglion is very short and originates in the carotid plexus. The sensory root of the ganglion comes from the tympanic plexus by way of the large deep petrosal nerve.

The otic ganglion, having a composition similar to the sphenopalatine, receives afferent sympathetic fibers from the middle meningeal arterial plexus, parasympathetic fibers from the small deep petrosal nerve and sensory cerebrospinal fibers from the facial and mandibular nerves by way of the small superficial petrosal nerve. The plexus forms anastomoses with the facial, vagus and trigeminal nerves and the intermediary nerve or nerve of Wrisberg over the tympanic membrane.

The ophthalmic ganglion, although this is not constantly verified in man, appears to be connected with the tympanic plexus by sympathetic fibers that transmit impulses producing dilatation of the pupil.

HERSON, Chicago

Pharynx

RELIEF OF TRISMUS IN INTRAORAL CANCER J G SCHOOLMAN, Eye, Ear, Nose
& Throat Monthly 27 269 (June) 1948

Separation of the attachments of the masseter, temporal and internal pterygoid muscles is presented as a simple surgical procedure to relieve the trismus frequently

encountered as a sequel to unilateral malignant growths in the posterolateral portion of the mouth. This trismus may be the result of local infiltration of the neoplastic lesion, metastatic nodes or local reaction to radiation therapy. Pain undoubtedly plays a role initially but is unimportant later. Even with deep anesthesia, there is usually little or no relaxation of the trismus.

JENNES, Waterbury, Conn

Larynx

STREPTOMYCIN IN OTOLARYNGOLOGIC TUBERCULOSIS A J VADALA, Laryngoscope
59 156 (Feb) 1949

There has been a marked decline in otolaryngeal tuberculosis in recent years, due to improved therapy.

Streptomycin administered intramuscularly has aided greatly. The aerosol proved unsatisfactory. Clinical cures were obtained in 18 of 28 cases of laryngeal tuberculosis, and in several cases of mastoiditis cures were obtained when streptomycin was used together with surgical intervention. There were few marked labyrinthine complications when the dosage was kept at 1 Gm a day. Only 1 case of loss of cochlear function could be attributed to streptomycin therapy.

HITSCHLER, Philadelphia

PHYSIOPATHOLOGY OF THE TRACHEOTOMY J MESNAGE, Rev de laryng 69 413
(Sept-Oct) 1948

Mesnage analyzes the changes produced in the tracheobronchial tree by tracheotomy. They are seen as occurring in three stages. First is a stage of imbalance of the autonomic nervous system, i.e., vagus predominance, resulting in bronchial constriction, which is transitory. The second stage is one of mechanical perturbation due to hypersecretion of tracheobronchial mucus, as the adaptation of the lower respiratory passages establishes itself. The author analyzes in detail the causes and the mechanism, as well as the nature, of this hypersecretion. A third stage is characterized by superimposed infections of the lower respiratory passages. These necessitate frequent aspirations of the tracheobronchial tree.

The pulmonary respiration is studied by the writer, it appears to be little perturbed at the stage of adaptation except for productive cough. The roentgenogram shows absence of gross alteration of the lung except for diminished clearing of the apexes in coughing. The auscultation signs (rales, etc.) appear due only to tracheobronchial changes.

HERSON, Chicago

Nose

DERMOID CYSTS OF THE NOSE A D DAVIS and R E BERNER, Plast & Reconstruct Surg 3 345 (May) 1948

Many cases of dermoid cysts of the nose have been recorded in the literature since 1933. The otolaryngologists are first confronted with the treatment of this type of cyst. The embryologic and anatomic discussion is complete and accompanied with several photographs of the 3 unusual cases presented. The authors summarize their article as follows: Dermoid cysts of the nose are not a rarity, approximately 50 cases have been recorded in medical literature. The dermoid cysts are of special interest because of their embryonic origin. The plastic surgeon should be aware of their origin and possible ramifications. In suspected cases, the diagnostic aids of roentgen rays and instillation of iodized oil U S P should be utilized to determine the extent and depth of the cyst. They may present a complex picture and are frequently not recognized or adequately removed.

SELTZER, Philadelphia.

NASAL HEMORRHAGIC TELANGIECTATIC BLEEDING CONTROLLED BY THE USE OF SYLNASOL JOSEPH KASNETZ, Eye, Ear, Nose & Throat Monthly 27 173 (April) 1948

Two patients with nasal hemorrhagic telangiectasis, a mother and her son, were treated with local injection of sylnasol® (5 per cent solution of the sodium salts of certain of the fatty acids of psyllum seed oil with 2 per cent benzyl alcohol), which the author finds preferable to various methods of cauterization or to irradiation in that destruction of the tissue is thus avoided. The injection is preceded by surface anesthesia with 2 per cent butacaine sulfate U S P (butyn sulfate®) or 5 per cent cocaine, after which 0.25 to 0.5 cc of sylnasol® is injected intramucosally at the area of bleeding, other areas, if present, are treated similarly. Occasionally, a secondary infiltration is necessary. There is minimal secondary reaction, local in character, consisting of mild mucosal swelling, with the subjective complaint of smarting or burning, which may last a few hours. JENNES, Waterbury, Conn

NASAL SINUSITIS EVALUATION OF SULFONAMIDES AND PENICILLIN IN ITS TREATMENT A R HOLLENDER, Eye, Ear, Nose & Throat Monthly 27 414 (Sept) 1948

Penicillin and sulfonamide drugs are not therapeutic panaceas for nasal sinusitis, they are effective only in certain circumstances, and then only as an adjunct to orthodox treatment. For acute sinusitis, chemotherapy is effective in shortening the course of the disease and in minimizing the course of complications if the infection is caused by drug-sensitive organisms, for chronic sinusitis, chemotherapy alone cannot be relied on for cure. Both penicillin and sulfonamide drugs may, however, be a valuable aid to indicated surgical or nonsurgical measures.

With regard to treatment of sinusitis with aerosol penicillin, the author presents conflicting reports from the literature to demonstrate that the measure is far from being a panacea. Because of the simplicity of administration, it has given the general practitioner a procedure which he can use without special training. This may result, therefore, in the delay of correctly indicated treatment, because in many instances the method may be used hastily without adequate evaluation and therefore without accurate diagnosis. Used correctly in suitable cases, the method undoubtedly possesses merits. This statement assumes the presence of several factors: (1) correct diagnosis, (2) efficient equipment and (3) frequent administration for maintaining therapeutic blood levels. Aerosol penicillin treatment cannot be expected to cure advanced sinusitis, especially of the hyperplastic type, in which the changes in tissue are irreversible. Though aerosol penicillin represents a definite advance in the administration of this drug for certain infections of the respiratory tract, the method may prove hazardous if employed inefficiently, especially before correct diagnosis is made.

The sulfonamide drugs and penicillin have certain definite limitations which must be understood if it is to be explained scientifically why these substances often fail to produce successful end results in acute and chronic sinusitis.

JENNES, Waterbury, Conn

Miscellaneous

HARELIP AND CLEFT PALATE REPAIR E C PADGETT, Plast & Reconstruct Surg 2 374 (July) 1947

In this paper the author reports the cases he presented at the 1946 meeting of the American Society of Plastic and Reconstructive Surgery. Included in the

series are 6 patients with single harelip, ranging in age from 2 months to 16 years, 5 patients with double harelip and palate defect, and 2 patients with double harelip without palate defect. Padgett chose 18 months as the routine age for operation, he used the Diffenbach-von Langenback method, which is briefly outlined. The procedures for reconstruction and repair are also considered. Excellent photographs of the lesions before and after operation are included.

SELTZER, Philadelphia.

ESTABLISHING A PRESERVED CARTILAGE BANK J. B. BROWN and MCCARTHY
DEMERE, *Plast & Reconstruct Surg* 3 283 (May) 1948

This is an excellent article on the establishment of a bank for preserved cartilage and contains material of especial interest for those concerned with reconstruction of the ears, nose and throat. The authors present the principles which must be kept in mind. A suitable extraneous substance possesses the following qualifications: 1 It must be sterile. 2 It must incite little or no tissue reaction. 3 It must be readily available in large quantities and preferably inexpensive. 4 It should be easy to work with and to carve. Forms and molds made prior to operation serve as good patterns, but are often different from the shapes needed at the time of operation. The substance chosen must be such that it can be fashioned quickly and accurately. 5 It should maintain the shape into which it is inserted, warping, curling, melting and dissolving are undesirable qualities. 6 It should be nonabsorbable.

The authors discuss the advantages of preserved homocartilage which are as follows: 1 Its procurement does not require a major surgical procedure, involving additional operating time and risk. 2 It is available in the quantity desired. 3 It is available in the quality and shape of cartilage needed. 4 It maintains the shape in which it was inserted. 5 Because of availability, it can be used as a temporary prosthesis or as a pattern for the later, permanent implant. 6 Sliced, chipped, diced and grated cartilage may be prepared from this preserved material and used as desired.

A method of organizing a preserved homocartilage bank is presented for use in conjunction with plastic surgery procedures. Appropriate cartilage is obtained at fresh autopsies, refrigerated (frozen if possible), thoroughly cleaned and again refrigerated in an aqueous solution of merthiolate®. Systematic bacteriologic studies are made. The advantages and disadvantages of preserved homocartilage are outlined.

SELTZER, Philadelphia.

THE RATIONALE OF BLOWING EXERCISES FOR PATIENTS WITH REPAIRED CLEFT
PALATES CLAUDE E. KANTNER, *J Speech Disorders* 12 281 (Sept) 1947

Blowing exercises in treatment of cleft palate are given early so that through such exercises the patient will learn better voluntary control of the palatal muscles and hence improve the use of these muscles and so strengthen and develop them. The first of these assumptions seems well founded, the second is logical but difficult to prove. Blowing exercises are valuable only when they motivate the patient to make the utmost use of the muscles involved. Presurgical training in this matter is useful. Blowing exercises should be begun at least within a month after surgical repair. The first of these exercises should be very easy, the violence of the breathing exercise is no criterion of its value. The exercise of blowing a balloon should be reserved until good closure of the palate has been made. Grimaces and contractions of the nares should be avoided. Blowing exercises have given their

maximum benefit when the patient has full awareness of the concept of oral direction of the air stream, when he is able with ease to contract and relax the muscles of the palate voluntarily and when he has attained the maximum degree of closure of the opening into the nasopharynx in terms of the structural and neuromuscular limitations of the soft palate and surrounding structures. The only valid criterion of palatal efficiency is the amount of air escaping through the nose in relation to the amount emitted orally. It is important that the total amount of air be expelled and that the length of exhalation be kept approximately constant, since in blowing against pressure the proportion of air escaping through the nose tends to rise as the breath pressure increases. The spirometer is useful, too, in measuring this efficiency. Blowing exercises themselves are useless without other training in the correction of cleft palate speech, they should not be given during periods of infection of the nose and throat or in cases in which the palate is so inadequate that there is no possibility of improvement. The amount of nasality in speech is not directly related to the amount of nasal flow of air. The speech of some patients with complete closure by the obturator is still extremely nasal, while that of patients with considerable opening is hardly nasal at all. In some patients extensive pharyngeal movements develop with very little improvement in speech, in others, these do not develop spontaneously at all. The question of pharyngeal movements has not been satisfactorily answered in the literature.

PALMER, Wichita, Kan

News and Comment

SECOND PAN-AMERICAN CONGRESS OF OTORHINOLARYNGOLOGY AND BRONCHESOPHAGOLOGY

The Second Pan-American Congress of Otorhinolaryngology and Bronchoesophagology will be held in Montevideo and Buenos Aires, Jan 8 to 15, 1950. The president is Prof Justo M Alonso, and the secretary general is Prof Pedro Regules.

Sessions will be held on the following subjects: Montevideo, January 9, 10 and 11, mornings: Frontal sinus, tumors of the pharynx, buccopharyngeal and laryngeal lesions caused by fungi or parasites, treatment of cancer of the larynx, conservative of function, bronchial obstruction in children, benign disease of the esophagus.

Montevideo, January 9, 10 and 11, afternoons: Nose and sinuses, pharynx and larynx, bronchoesophagology.

Buenos Aires, January 13 to 14, mornings: Word hearing, audiophone and audiometer, otosclerosis.

Buenos Aires, January 13 to 14, afternoons: Inflammatory diseases of the ear and their complications, otosclerosis and its treatment.

During the following week (January 16 to 21), operative demonstrations will be held in Montevideo and Buenos Aires for those who wish to attend.

Travel arrangements should be made immediately through Thomas Cook & Son, Inc, or Pan American World Airways. All those interested in attending this congress should communicate at once with the delegate from the United States and Canada, Dr Chevalier L Jackson, 3401 North Broad Street, Philadelphia 40.

CUBAN SOCIETY OF OTOLARYNGOLOGY

The following officers have been elected for 1949 and 1950: president, Dr Remaldo de Villiers, vice president, Dr Cesar Cabrera Calderin, secretary, Dr Jose Xirau, treasurer, Dr Alfredo M Petit, voters, Dr Jose Gross and Dr Pedro Hernandez Gonzalo.

AMERICAN BOARD OF OTOLARYNGOLOGY

The American Board of Otolaryngology will conduct the following examinations in 1950: January 8-11, in New Orleans, at the Hotel St Charles, May 17-20, in San Francisco, at Hotel Mark Hopkins, October 3-6 in Chicago, at the Palmer House.

Book Reviews

Répercussions sur l'enfant des maladies infectieuses de la mère pendant la grossesse (toxoplasmose et embryopathie rubéoleuse en particulier) Etude clinique, encéphalographique et sérologique By F Bamatter, Privat Docent Price, 7 50 Swiss francs Pp 60, with 24 illustrations and 5 tables Basel, Switzerland S Karger, 1949

This is a work from the department of ophthalmology of the University of Geneva, Switzerland The introductory chapter deals with the role of exogenous factors (application of roentgen rays to the mother's pelvis or to the father's testis, administration of estrogens, use of contraceptive agents, lead poisoning) in the production of congenital malformations, particularly during the first ten weeks of pregnancy It also deals with various infections (cocci, bacilli, viruses) occurring in the mother

Toxoplasmosis, recently studied by Wolf and Cowen, a specific granulomatous inflammatory process (encephalitis, chorioretinitis) produced by a crescentic protozoan, when transmitted from mother to infant may, according to the author, take three forms acute, subacute (with encephalitic symptoms convulsions, stupor, areflexia, amblyopia, hydrocephalus) and chronic (latent) Laboratory studies of the spinal fluid show albuminocytologic dissociation, and roentgenograms reveal intracerebral calcifications (not specific) Funduscopy shows characteristic bilateral central macular and perimacular chorioiditis and areas of atrophy surrounded by pigmentation, often connected with the disk by preretinal striae In the chronic form of toxoplasmosis the changes in the eyegrounds, intracerebral calcifications and results of serum neutralization tests are important diagnostic elements, the chronic form often manifests itself only by amblyopia with associated convergent squint, or it may be entirely asymptomatic Personal cases are reported and analyzed

Rubella, when contracted by the mother during the first ten weeks of pregnancy, particularly from the fifth to the eighth week, may produce various congenital malformations in the fetus cataracts, abiotrophy, cardiac malformations, microcephalus and congenital deafness Epidemics of rubella were first observed as producing series of congenital cataracts by Gregg, in Australia, then by Swan, Mayo, Perera and Altmann, in the United States, Debre, in France, and Franceschetti, in Switzerland The author reports 7 personal cases The first was that of a 14 month old boy with congenital cataracts, retinal pigmentation and deafness with remnants of hearing for tones of about 11,000 frequency There was no response to rotary tests, and encephalograms showed absence of pneumatization of the ventricles The second patient, of the same age as the first, whose mother had rubella the third week of pregnancy, also showed bilateral cataract, retinal pigmentation, hypospadias and bilateral deafness The third patient, a 2 year old girl, whose mother contracted rubella in the sixth week of pregnancy, exhibited deaf-mutism, microcephalus and retinal pigmentation, the fourth, a 13 month old girl, had cardiac malformation, and the fifth, a 6 year old girl, whose mother contracted rubella in the third month of pregnancy, had complete deafness with no remnants of hearing, as well as pronounced vestibular hypoexcitability in the caloric test In the rotary test she showed normal response for the vertical canals and no response for the others, she also had a cardiac murmur and retinal pigmentation

Besides rubella, varicella in pregnant women was found to cause multiple malformations in the embryo, such as hydrocephalus (Lynch), atrophy of the optic nerve and aplasia of the cerebral cortex. The same malformations might occur from measles and from poliomyelitis occurring during early pregnancy. The author stresses that infections are injurious to the young nervous tissue of the embryo in the early stage of differentiation.

Chirurgie de l'oreille, du nez, du pharynx et du larynx By Maurice Aubry
Fourth edition. Boards. Price, 3,000 francs. Pp 965, with 729 figures.
Paris: Masson et Cie, 1948.

This volume is a revised reprint of the classic volume on French otolaryngologic surgery last printed in 1936, with Dr. Georges Laurens, since deceased, as co-author. The present edition is inspired by the teachings of Dr. Albert Hautant, one of the prominent Parisian otolaryngologists, whose assistant the author was. Many surgical descriptions are simplified, new procedures added and chapters on antibiotics developed.

Surgery of the Ear—Revised technics of otoplasty are presented, treatment of macrotia, after Goldstein and Lexer, is described, and a new technic of total reconstruction of the auricle and of treatment of atresia of the external auditory canal is reported. For chronic suppurative otitis media, besides the routine technics of postauricular radical mastoidectomy (Schwartz, Stacke, Wolf), the endaural route is described, with Lempert's three meatal incisions (as used in fenestration), as well as procedures of modified radical mastoidectomy: antroatticotomy, after Heath (without opening the tympanic ring) and after Sourdille (with trepanation of the tympanic ring), and antroattical mastoidectomy, after Ramadier, all three procedures being carried out by the retroauricular route, with the meatal skin flap covering the operative cavity. For petrositis, the Ramadier and Almour technics are reported, as well as the apical resection of Lempert. For labyrinthitis are described the procedures of trepanation after Hautant (removal of the bony bridge between the oval and the round window and opening with curettement of the vestibule), after Gaston (trepanation of the cochlea) and after Richard (addition of an opening in the semicircular canals to the trephine opening). Cerebral otogenous abscess, if acute, is treated by drainage and topical instillation of penicillin two to three times daily; chronic encapsulated abscess is removed with the capsule by resection after the technic of Clovis Vincent.

The chapter on otosclerosis is much enlarged. In it the author describes the postauricular route in the three stages of the Sourdille operation, the endaural technic of Lempert with three meatal incisions, A, B and C, and a personal simplified Lempert technic with two endaural incisions, A-B and A-C, and trepanation of the attic, but with construction of two flaps for the aditus and fistula. In the chapter on vertigo, trepanation of the labyrinth after Hautant, section of the eighth nerve and the Portmann operation are described.

Surgery of the Nose and Sinuses—A new personal method of correction of septal perforation is reported, together with Seiffert's technic. Seltzer's procedure of rhinoplasty for deviated nasal tip is described, visualization of the sphenoid sinus as a diagnostic procedure is advocated, and a personal method of closure of antral-buccal fistulas is reported (double mucosal flap, the posterior, Indian type, overlapped by a sliding palatal flap). Treatment of ozena by inclusion of an acrylic implant in the septum, the floor of the nasal fossa and the lower meatus is described.

Surgery of the Pharynx and Larynx—Newly reported for cancer of the larynx are Portmann's laryngectomy in three stages and the Vasconcelos-Barretto pro-

cedure with clamp, in addition to a personal technic of laryngectomy in one stage modified from that of Hautant. A new method, in two stages, for recurrent laryngostenosis is described. An Indian flap is sutured in the laryngostomy opening, and three weeks later the hyoid bone is dissected and hinged on the right horn, then placed between spread halves of the thyroid cartilage and sutured to the alar perichondrium and prelaryngeal tissues on the left side.

For paralysis of the dilator muscles the Retlu procedure, as well as the King and the Kelly technic, is described. The book is abundantly illustrated with excellent drawings.

The Temporal Bone and the Ear By Theodore H. Bast and Barry J. Anson
Price, \$12 Pp 478, with 426 illustrations Springfield, Ill Charles C Thomas, Publisher, 1949

This is a classic reference book on the embryology and anatomy of the ear and temporal bone in man. Based almost entirely on original research, new concepts, so direly needed, are presented relative to the structure and function of the ear. Many of the problems that have long been neglected and theories that have been erroneously accepted are here clarified.

The volume is organized on a developmental basis. Detailed discussions are given on the otic labyrinth, the periotic labyrinth and the otic capsule. These three names are emphasized in order to give lucidity and meaning to future discussions on the complex structure of the temporal bone. An excellent chapter is included on the histologic variations and pathologic processes in the temporal bone. The book concludes with a comprehensive, objective historical review on the function of the inner ear.

The numerous photographs and illustrations throughout the book are unusually clear. Countless new details of structure and several basically new concepts are presented. The authors have done a brilliant job in investigating the subjects and coordinating the material in so clear a manner. This book has already made itself felt as a major classic contribution to the field of otology.

Headaches, What Causes Them, How to Get Relief By Noah D. Fabricant, M.D. Price, \$2.50 Pp 149 New York Farrar, Straus & Co., Inc., 1949

The purpose of this book is to tell the headache sufferer, who may be dosing himself with worthless remedies, how serious may be his delay in visiting a physician. Because headache is often taken too lightly, there is a real need for thorough discussion of this common condition. This book considers headache caused by eyestrain, by sinus infection and by high blood pressure. Migraine is described in its many forms. The more serious headaches, such as those caused by cerebral disturbances and injuries, are discussed fully. There are discussions on the various treatments of headaches. Owing to the fact that headache is a symptom of a disease and not a disease itself, the diagnosis and treatment have become more exact than ever before.

The book serves to make the reader conscious of the fact that if a headache persists it is important to see a physician for relief, and not to take casually drugs that merely alleviate the pain without correcting the cause.

Directory of Otolaryngologic Societies *

INTERNATIONAL

FOURTH INTERNATIONAL CONGRESS OF OTOLARYNGOLOGY

President Dr V E Negus, London, England
General Secretaries Dr F C W Capps and Dr W A Mill, 45 Lincoln's Inn
Fields, London, W C 2
Place London Time July 18-23, 1949

SECOND PAN-AMERICAN CONGRESS OF OTO-RHINO-LARYNGOLOGY AND BRONCHESOPHAGOLOGY

President Prof Justo Alonso
Secretary Dr Chevalier L Jackson, 255 S 17th St, Philadelphia 3
Place Montevideo Time January 1950

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON LARYNGOLOGY, OTOTOLOGY AND RHINOLOGY

Chairman Dr William H Johnston, 1515 State St, Santa Barbara, Calif
Secretary Dr J Milton Robb, 1553 Woodward Ave, Detroit 26, Mich

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President Dr J Mackenzie Brown, 1136 W 6th St, Los Angeles 14
Executive Secretary-Treasurer Dr William L Benedict, 100-1st Ave Bldg,
Rochester, Minn

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President Dr LeRoy A Schall, 243 Charles St, Boston
Secretary Dr Edwin N Broyles, 1100 N Charles St, Baltimore 1
Place Hotel Mark Hopkins, San Francisco Time May 25-26, 1950

AMERICAN LARYNGOLOGICAL ASSOCIATION

President Dr Frederick T Hill, 177 Main St, Waterville, Maine
Secretary Dr Louis H Clerf, 1530 Locust St, Philadelphia 2
Place Hotel Mark Hopkins, San Francisco Time May 23-24, 1950

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOTOLOGICAL SOCIETY, INC

President Dr Robert C Martin, 384 Post St, San Francisco
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SURGERY AT THE BASE OF THE TONGUE BY TRANSPHARYNGEAL APPROACH

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THE SECURITY today which is due to the new method of total laryngectomy permits considering enlargement of the surgical field toward the esophagus and the trachea as well as toward the pharynx and the base of the tongue. Particularly surgery at the base of the tongue has remained of extreme seriousness, and one hesitates even when such a procedure seems the logical therapeutic measure. Especially is this so when one contemplates an external approach.

With laryngectomy one has an extremely easy route to the hypopharynx and the laryngopharynx. When the larynx has been removed and the head is hyperextended, the oropharynx may be inspected, and the base of the tongue and the glossoepiglottic groove and tonsils are brought into view. The tongue may thus be easily approached.

TECHNIC

After the larynx has been removed, the body of the hyoid bone is removed. Then, with Museum forceps, the base of the tongue is grasped and pulled out of the operative opening. The resection of the muscular layers involved is made with strong scissors or the knife. When the resection is made, a strong silk suture is placed in the section of the tongue and the operation is finished by a pharyngostomy, as in the classic laryngectomy.

Of course, the principal indication for the operation is tumor of the epiglottic region and the base of the tongue, but, in addition to its use in cases of laryngeal involvement, the translaryngeal approach may be employed when the tumor is located at the base of the tongue with or without involvement of the glosso tonsillar grooves and the inferior poles of the tonsils.

Because with tumors of the first type the epiglottis is invaded and the tumor extends more or less into the laryngeal vestibule, the classic total laryngectomy is necessary, with the second type, on the contrary, I modify the technic by limiting the operation to the upper part of the larynx, even maintaining in some cases the integrity of the vocal cords and the arytenoid cartilages.

The time for surgical intervention is after (1) previous substernal tracheotomy or (2) pharyngolaryngectomy. The procedure, which differs from the classic laryngectomy, is carried out in the following steps:

First Step—Incision in an arc, comprising a transverse curvilinear incision in the inferior concavity, passing about 1 cm over the hyoid bone, and a vertical incision down the superior surface of the cricoid cartilage. The cutaneous layers are retracted on each side and held with forceps.

Second Step—Section of the subhyoid muscles close to the hyoid bone and of the laryngeal skeleton on its lateral aspect at the level of the thyroid cartilage

Third Step—An oblique section from front to rear and upward to the thyroid cartilage, made by passing from the middle of its anterior angle. The Liston forceps is used, and the incision is begun transversely, by opening the thyroid cartilage a few millimeters under its concavity. The larynx being opened, a strong scissors for the oblique section of the alae of the thyroid cartilage is helpful.

This section, which opens the laryngeal vestibule above the vocal cords, exposes the posterior part of the aryepiglottic folds. The anterior fragment of



Fig 1—A, cross bow incision, B, section of the thyroid cartilage above the anterior commissure, C, resection of the superior fragment of the thyroid cartilage and of the epiglottis, D, retraction of the thyroepiglottic fragment with the vocal cords and the pharynx apparent

the laryngeal skeleton on which the epiglottis rests is held by a Museux forceps, producing strong tension and shortening the time of operation

Fourth Step—Section of the preepiglottic layers, the knife passing between the epiglottis and the hyoid bone, and ablation of the epiglottis and the portion of the thyroid cartilage

Fifth Step—Resection of the body of the hyoid bone, previously separated from its muscular attachments

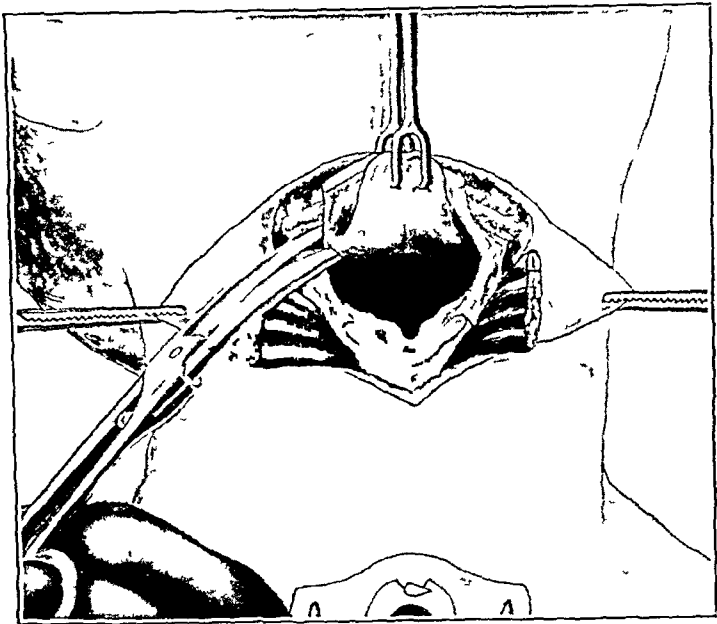


Fig 2—Preepiglottic resection of body of the hyoid bone

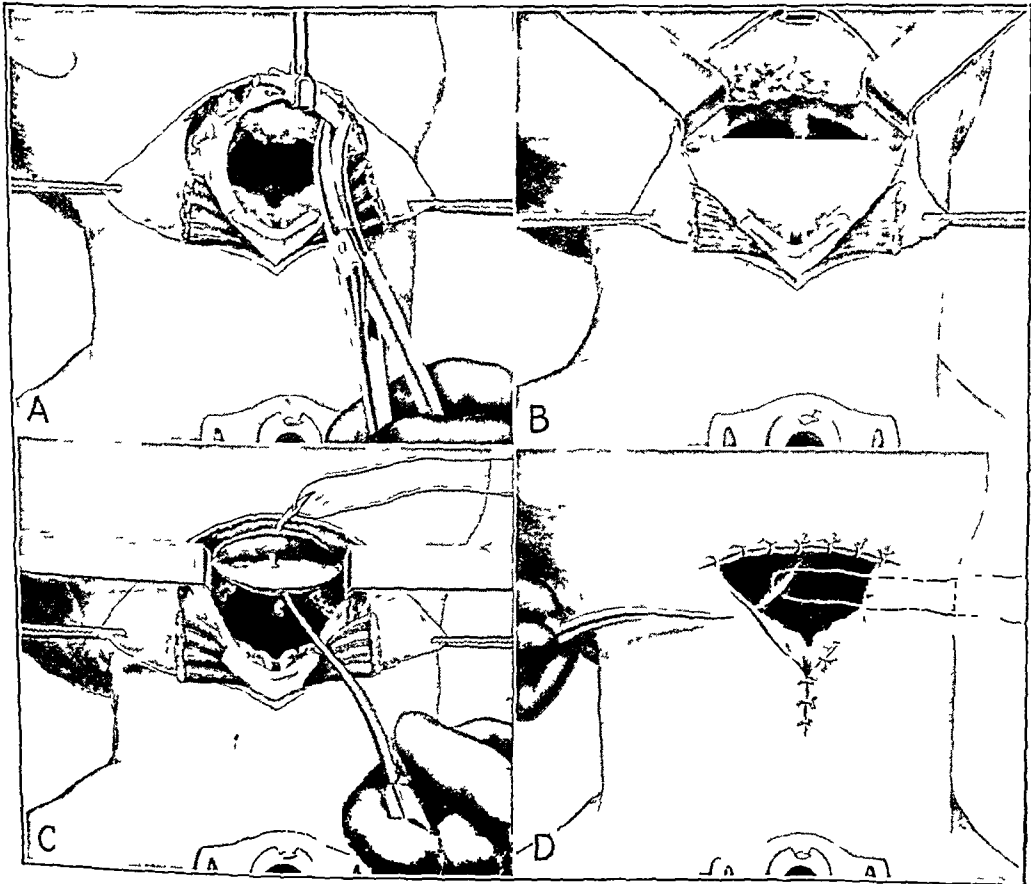


Fig 3—A, section of the hyoid bone, B, exposition of the base of the tongue with the tumor, C, suture of the base of the tongue following removal of the tumor, D, suture of the skin to the pharyngeal mucous membrane

Sixth Step—Fixation of the base of the tongue with Museux forceps and delivery through the operative opening by easy traction

Exploration by sight and with the fingers permits the operator to learn the precise limits of involvement. Normal tissue is then incised, and all diseased tissue is removed from the base of the tongue.

Seventh Step—Placement of a suture of strong silk at the opening in the base of the tongue.

Eighth Step—Formation of a pharyngostomy opening by suture of the skin to the mucous membrane of the laryngeal vestibule and the piriform sinuses on the sides and at the base of the tongue, above and forward.

Ninth Step—Placement of an alimentary tube through the nasal fossae and pharyngeal packing by the Mikulicz technic.

This packing, by pressing on the vocal cords, prevents the collapse of the trachea and entirely blocks the airway. In some cases nothing prevents one from making a temporary suture of the vocal cords. If the passage of the alimentary tube through the nose proves disagreeable to the patient, a gastrostomy fistula can be made.

Use of the translaryngeal approach in operations on the base of the tongue offers, in addition to the advantage of security, the opportunity of observing for a long time the development of the lingual cicatrization and of placing tubes of radium, if this is thought necessary.

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PERILYMPH ITS RELATION TO THE IMPROVEMENT OF HEARING WHICH FOLLOWS FENESTRATION OF THE VESTIBULAR LABYRINTH IN CLINICAL OTOSCLEROSIS

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IN A PAPER read before the combined meeting of the sections on Otolaryngology of the New York Academy of Medicine and the Philadelphia College of Physicians, March 20, 1940, one of us (J L) ¹ stated

It has been known and observed for very many years that when a fistula is made in the vestibular portion of the bony capsule of the labyrinth in an otosclerotic ear, before cochlear nerve degeneration has taken place in the conversational frequencies, there occurs an immediate improvement of hearing for air-borne sound of the highest obtainable degree in that patient. Most otologists who observed this phenomenon, and some who occupied themselves with the development of the surgery for otosclerosis, have always believed that the improvement of hearing resulting from such a fistula was the direct result of the decompression of a supposedly existing, but never proven, increased intralabyrinthine fluid pressure. Despite their observation that the hearing improvement could be temporarily maintained after such a fistula was covered and sealed tightly with a membrane, thus permitting the perilymph to refill the perilymph space, they still adhered to the theory of decompression.

Holmgren ² argues that there exists the possibility of the perilymph being resorbed through the membrane covering the fistula. Sourdille ³ advanced a half-bottle theory to support the theory of decompression.

From the Lempert Institute of Otolology and the Lempert Research Foundation, Inc

¹ Lempert, J. Endaural Fenestration of the Horizontal Semicircular Canal for Otosclerosis. Indications, Technique, Observations as to Early and Late Post-Operative Results, *Laryngoscope* **51** 330-362 (April) 1941

² Holmgren, G. The Surgery of Otosclerosis, *Ann Otol Rhin & Laryng* **46** 3-12 (March) 1937

³ Sourdille, M. New Technique in the Surgical Treatment of Severe and Progressive Deafness from Otosclerosis, *Bull New York Acad Med* **13** 673-691 (Dec) 1937

My own observations have failed to reveal any facts which could help support this theory. On the contrary, they all pointed away from it. At no time was I able to observe an escape of perilymph into the mastoid wound which could compare to the escape of spinal fluid following the minutest opening of the subarachnoid space. I never saw the perilymph reach beyond the level of the lumen of the semicircular canal, though I have patiently watched for it for periods of as long as two hours, thus convincing myself that the perilymph was never under increased pressure in these cases. By removing the perilymph and watching for it to refill the perilymph space, the slowness with which the perilymph entered the perilymph space led me to suspect that there must exist a natural barrier between the cerebrospinal fluid system and the perilymph space which controls the flow of perilymph and permits only as much perilymph to get through as is necessary to cushion the membranous labyrinth with its endolymph, and enough to maintain the necessary amount of pressure relationship between the perilymph and endolymph, but no more. Whereas, perhaps in and under certain conditions the amount of endolymph may be increased, this is always at the expense of the perilymph space, which then permits a lesser amount of perilymph to enter and cushion the endolymph. Thus a change in normal pressure relationship between the perilymph and endolymph may occur, but no increased perilymph pressure within the lumen of the canal was ever observed to exist.

If the decompression theory had a basis in fact, a fistula in the cochlear promontory should result in improved hearing, but it never does. Neither does the creation of a new window in the external semicircular canal improve hearing when either the round window alone or both the oval and round windows are functionally impeded. Whereas a new window created in the external semicircular canal in the presence of a functionally impeded oval window does improve hearing by air conduction, if the round window membrane is normal. Since two functionally unimpeded windows, one in the vestibular part and another in the cochlear part of the bony labyrinthine capsule, are essential to improve air conduction hearing, and since it is possible to maintain the hearing improvement obtained by fistulization after covering and sealing the fistula with a membrane, I am convinced that the hearing improvement obtained following fistulization of the external semicircular canal is not the result of decompression of intralabyrinthine fluid pressure but rather the result of the mobilization of the perilymph and endolymph by air-borne sound, which was heretofore hindered by the functionally impeded oval window, and which the newly created window in the external semicircular canal again makes possible.

The foregoing statement of March 1940 was based on observations made in 150 fenestration operations performed up to that time. Today, on the basis of more than 4,000 fenestration operations, this statement can be reaffirmed. Fluid never escapes from the perilymph space beyond the bony margins of the newly created fenestra into the mastoid wound.

Further observations that are pertinent to this point come from performance of the Lempert decompression operation for the relief of vertigo in Ménière's disease. In the earlier form of this operation the semicircular canal was opened, and this opening of the semicircular canal failed in every instance to produce any visible escape of perilymph. In the present form of this decompression operation the stapes and the round window

membrane are removed instead, and, as soon as this is done, the perilymph escapes freely

These facts find a ready explanation in certain histologic peculiarities of the perilymph spaces of the labyrinth. As is general for all the vertebrates,⁴ and as we have verified in detail for the monkey and man (figs 1, 2 and 3), the perilymph space of the semicircular canals and the vestibule is pervaded by a fibrous trabecular system, a meshwork of delicate connective tissue that extends from the perilymphatic endosteum-lined walls to the enclosed endolymphatic labyrinth and is complete with



Fig 1—Perilymphatic trabeculae surround the membranous ampulla of the posterior semicircular canal. Note the congested vessels

arteries and veins. This meshwork entraps the perilymphatic fluid like the tissue of a sponge, and effectively prevents any free and continuous flow. On the other hand, the cisterna perilymphatica just beyond the footplate of the stapes, the scala vestibuli and the scala tympani of the cochlea are devoid of any trabecular network, the perilymph there is unobstructed and it flows out freely when the oval and round windows are opened (fig 4)

⁴ de Burlet, H. M. *Vergleichende Anatomie des statoakustischen Organs*, in *Handbuch der vergleichenden Anatomie der Wirbeltiere*, Vienna, Urban & Schwarzenberg, 1934, vol 2, pp 1293-1444

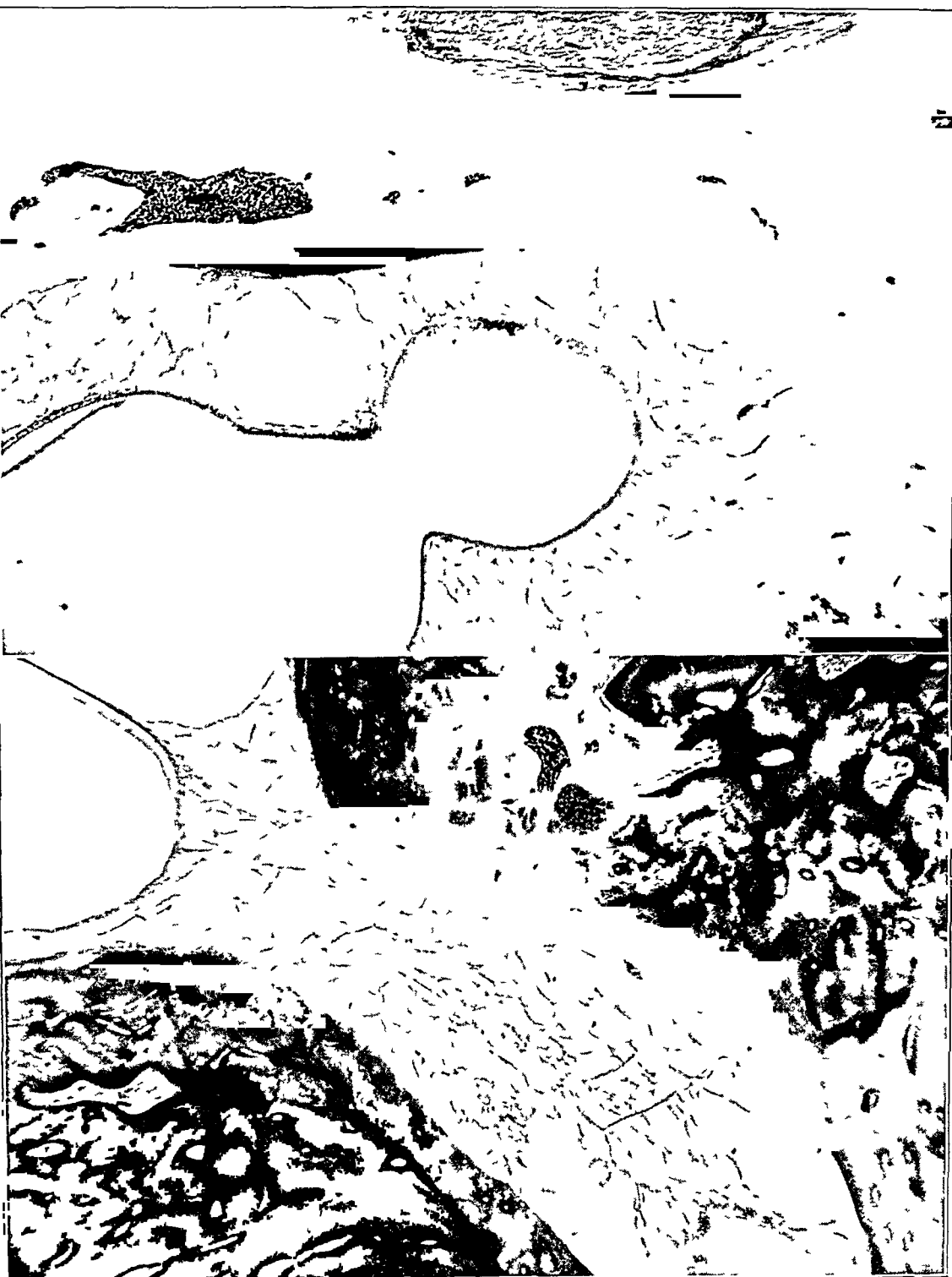


Fig 2—Upper The perilymphatic trabeculae support the membranous labyrinth and convey the minute vascular channels in the horizontal canal of an infant aged $2\frac{1}{2}$ months. Lower Perilymphatic trabeculae support the endolymphatic labyrinth and convey the vascular channels in the region of crus commune of an infant aged $2\frac{1}{2}$ months.



Fig 3—Upper Detail of the intricate meshwork of endothelial cells which comprise the perilymphatic trabeculae and convey the minute vascular network of an infant aged $2\frac{1}{2}$ months. Lower A blood vessel travels through the perilymphatic trabeculae, parallel to the bony wall of the crus commune, of an infant aged $2\frac{1}{2}$ months.

Holmgren⁵ in a recent article again revived his contention that the hearing improvement following fenestration is the result of drainage of perilymph, which is under pressure in clinical otosclerosis. In referring to the instance in which hearing improved during the creation of the fenestra in clinical otosclerosis he stated

that this great hearing improvement appeared at the same moment as perilymph fluid was noted, even if in such cases no opening in the osseous canal could be observed even with ten times magnification

From this statement it would appear that the perilymph pressure is so high that it is strong enough to penetrate the perilymphatic endosteum

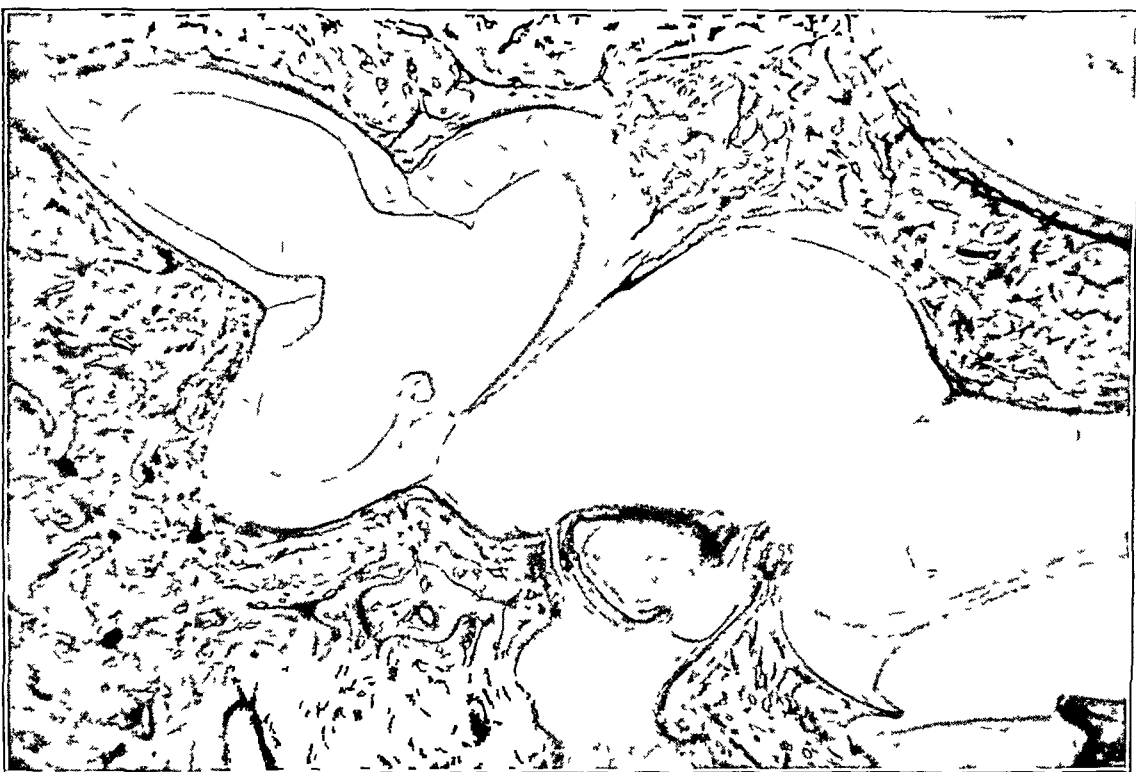


Fig 4—Perilymphatic trabeculae support the endolymphatic labyrinth in the regions of the sinus utriculi and the ampullae of the superior and horizontal canals of W F, 14 years old. They are completely absent in the cisterna perilymphatica, just beyond the footplate of the stapes, and in the scala vestibuli and the scala tympani

and the endosteal and enchondral bony layers of the labyrinthine capsule without a visible perforation. Holmgren⁵ asserted that failure of otologists doing fenestration surgery to observe the escape of perilymph is due to the fact that they make the fenestra in the presence of fluid within the mastoid cavity. He stated that if they would fenestrate in a dry field they would readily observe the escape of perilymph under pressure

⁵ Holmgren, G. To the Development of Otosclerosis Surgery, *Acta otolaryng* 37 26-29 (Feb) 1949

One of us (J L) has fenestrated in both dry and wet surgical fields and at no time has been able to observe perilymph escaping through the newly created vestibular fenestra. Furthermore, it is beyond comprehension how perilymph could penetrate the nonsevered perilymphatic endosteal membrane and the endosteal and enchondral layers of the bony capsule without a perforation visible under a magnification of ten times.

If it were true that the escape of perilymph would be necessary to improve the hearing in clinical otosclerosis, then the very leaving of the endosteal membrane intact, if this were always possible after removing the entire osseous wall, would still prevent such improvement, because no escape of perilymph can take place through an intact endosteum devoid of perforations and much less through an intact bony capsule of the labyrinth without perforations visible under a magnification of ten. One of us (J L) in 1944 performed several hundred fenestration operations, leaving the endosteum intact as often as possible, which is not always possible, and never saw perilymph escaping under pressure whether the endosteum was intact, perforated or removed. However, it was always observed with this technic and all the other variations of technic in the fenestration operation

that this great hearing improvement appeared at the same moment as an opening through the osseous canal is made down to the endosteal perilymphatic membrane and before the perilymphatic space has been opened.

CAN THE HEARING LOSS IN CLINICAL OTOSCLEROSIS BE DUE TO INCREASED PERILYMPH PRESSURE?

Before attempting to answer the question posed in the foregoing title it is at once necessary to call attention to the fact that there has never been any scientific proof that the perilymphatic pressure is greater in an otosclerotic ear than in a normal ear. However, if the improvement of hearing which follows the fenestration operation in clinical otosclerosis were the result of a permanent decrease of a supposedly existing increased perilymph pressure, then the natural inference should be that increased perilymphatic pressure can either directly or indirectly cause deafness.

In 1942 Bekesy⁶ investigated experimentally in temporal bones of fresh cadavers whether increased vestibular perilymphatic pressure will interfere with sound being transmitted through the middle ear and through the perilymphatic cochlear fluid. He stated

It has been stated that a high static pressure in the cochlea pushes the stapes out and reduces its mobility. If the stapes is relatively immobile for many years, blood supply to, and other functions of, the ear are impaired and this leads finally to otosclerosis.

⁶ Bekesy, G. V. Ueber die Schwingungen der Schneckentrennwand beim Präparat und Ohremodell, *Akust. Ztschr.* 7: 173-186, 1942.

To verify this assumption I changed the static pressure in the vestibular organ by injecting water by means of a hypodermic needle with a weight on the piston of the syringe. By rotating the piston continuously with special equipment it was possible to reduce the friction in the glass tube so that the pressure in the fluid could be calculated from the weight.

To determine the maximum change which might be expected in the transmission of the vibrations to the inner ear I first measured the maximum static pressure that the inner ear could bear. In the experiments I found that at a pressure of about 4 atmospheres a faint click was heard in the temporal bone, and after this the bone began to drip. Probably one of the blood vessels had burst. Special preparations of the round window showed that the round window ruptured at static pressures of from 4 to 7 atmospheres. Since the stapes was not affected by the maximal pressures which could be produced in the cochlea, I measured the force necessary to tear it out by a hook attached to the stapes itself. This force was about 320 grams, which corresponds to a pressure of 16 atmospheres on the footplate of the stapes.

After these preliminary measurements on several very fresh temporal bones the volume displacement of the round window was measured for 300 and 1000 cycles per second by adjusting the current in the earphone so that the tone in the ear of the observer was minimal. This adjustment was so exact that the smallest change in phase or amplitude of vibration of the round window could easily be detected. In general, no changes were observed as the inner pressure in the cochlea was continuously increased, until just before the inner ear started to drip, when there was a change in amplitude of about 10 to 20 per cent. Therefore, increasing the pressure in the inner ear probably does not immobilize the footplate of the stapes.

In spite of this experimental proof furnished by Bekésy that increased perilymphatic pressure does not affect the mechanism by which sound is transmitted through the middle ear and through the perilymphatic cochlear fluid, Holmgren in 1949 is still of the impression that the improvement following the fenestration operation is due to a decrease of perilymph pressure. Because of our great respect for Holmgren as an otologist and scientist and because of our constant desire to seek the scientific truth in otology, we decided to carry the investigation of the effects of perilymph pressure further than Békesy did. Our research project had two particular objectives in view. First, to investigate whether Békesy's experimental findings in cadaver material, that increased perilymphatic fluid pressure does not interfere with the mechanism by which sound is transmitted through the middle ear and through the cochlear fluid, can be substantiated in the living animal, second, to determine whether increased perilymphatic pressure will interfere with the activity of the sensory cells of the organ of Corti.

EXPERIMENTAL TESTS

Experiments were carried out on a monkey by the following procedure.

Through a postauricular incision, the antrum of the mastoid process was opened. The posterior bony wall of the external auditory canal was removed,

exposing to view the external semicircular canal and the round window niche without disturbing the tympanic membrane and the ossicular chain. An electrode consisting of a wire tipped with platinum foil was placed in contact with the round window membrane, and an indifferent electrode was placed in muscle tissue at the edge of the incision. From these electrodes the cochlear potentials were observed in response to stimulation with sound vibrations.

The electroacoustical apparatus is shown in figure 5. Tones were produced by means of audiometer and amplifier working into a loud speaker. The sounds were conveyed by a tube to a point opposite the animal's ear. The electrical potentials picked up from the cochlea were led through a shielded cable to an amplifier and then to a selective voltmeter (a General Radio Type 736-A wave

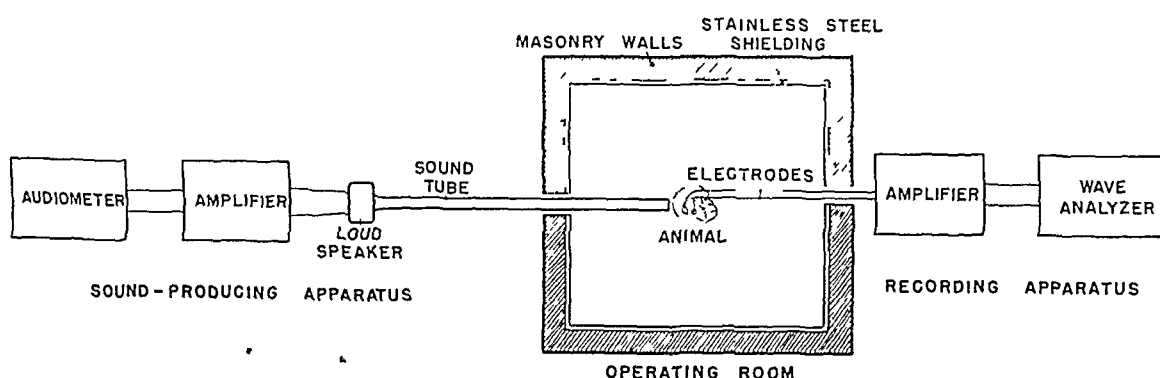


Fig 5—Apparatus for investigation of the electrical potentials of the cochlea

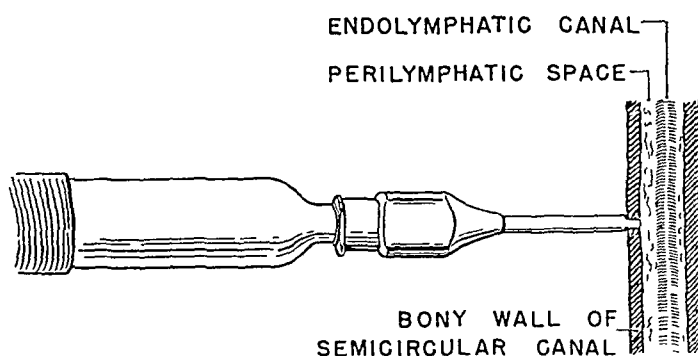


Fig 6—A special pressure needle is shown inserted through an opening in the bony wall of the semicircular canal

analyzer) for measurement. The operating room was acoustically isolated and electrically shielded, and, as is always necessary in this type of experiment, a number of tests were carried out to exclude the possibility of artefacts.

After a series of normal observations, a round opening was drilled through the bony wall of the ampullated end of the lateral semicircular canal up to the perilymph space without injuring the endolymphatic labyrinth. With a special tool this opening was reamed to a diameter just fitting snugly a no. 25 hypodermic needle. A special "pressure needle" was made by grinding flat the end of a no. 25 hypodermic needle and slipping over it a sleeve made of a piece of a larger needle, and soldering this piece so as to leave the end of the smaller needle protruding about 0.5 mm (fig 6). The end of this needle was inserted in the

opening in the bony wall of the canal. The sleeve prevented its entering too far and aided in the production of a tight junction.

The pressure needle was connected by rubber tubing and a Y tube to a large hypodermic syringe and a pressure gage (fig 7). Pushing on the plunger of the

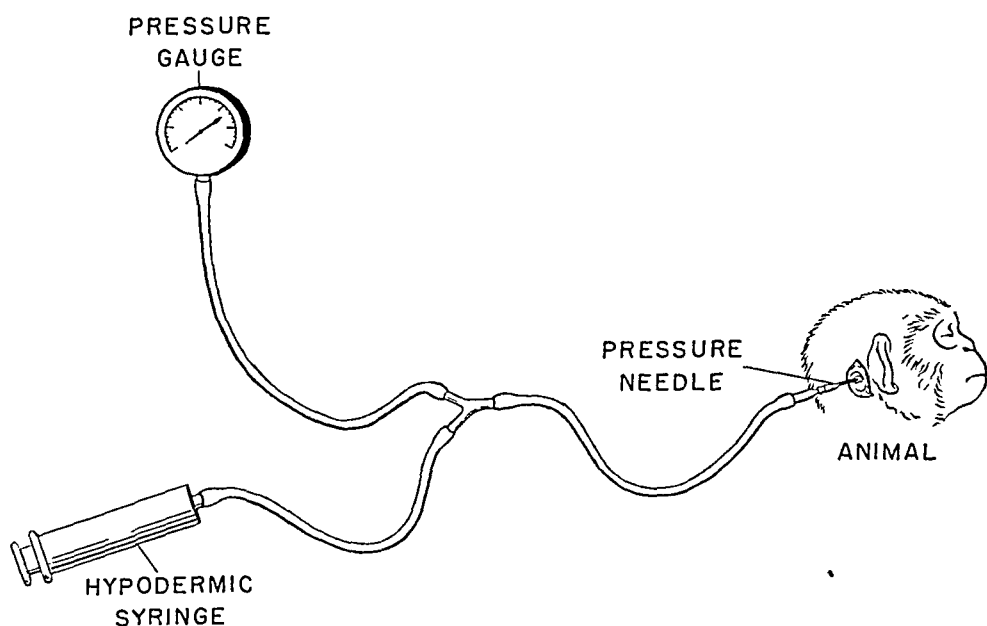


Fig 7—The pressure apparatus

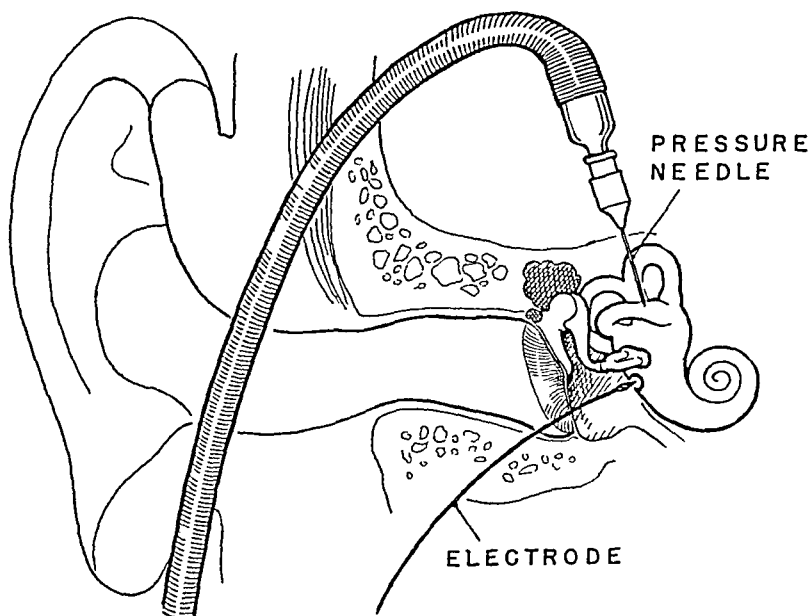


Fig 8—Detailed sketch of the manner in which the pressure needle is inserted into the lateral semicircular canal and the recording electrode applied to the round window membrane

syringe compressed the air in the system to a pressure indicated by the gage, and this same air pressure was applied to the perilymphatic fluid of the canal

Figure 8 shows in detail the placing of the pressure needle and the recording electrode

While a tone was sounded at a constant intensity, the cochlear potentials were measured for the zero pressure condition, and then the pressure was raised to a desired level and the measurement repeated, after which the pressure was restored to zero for a further measurement. This procedure continued, with alternate observations at zero pressure and various positive pressures, for a total of twelve trials. In most of the trials the stimulating tone was 512 cycles. That the pressure was communicated to the cochlea was proved by visible movements of the round window membrane.

As the accompanying table shows, the exertion of positive pressures up to 50 mm of mercury caused no appreciable changes in the magnitude of the cochlear potentials.

Effects of Exertion of Positive Pressures on Magnitude of Cochlear Potentials

Trial	Tone	Zero Pressure Before	Positive Pressure, 10 mm Hg	Zero Pressure After
1	512	23	23 Positive pressure 20 mm Hg	23
2	512	25	25 Positive pressure 50 mm Hg	23
3	512	15	16	16
4	512	7	7	7
5	512	5.5	5.5	5.0
6	512	15	15	15
7	512	5	5	5
8	512	6	6	4
9	512	16	16	16
10	512	15	15	15
11	512	5	6	6
12	2,048	19	19	19

CONCLUSION

Our observations in the living monkey are in full agreement with those of Békésy in human cadaver material. An increase of perilymphatic pressure up to 50 mm of mercury has no effect on transmission of sound vibration through the middle ear and the cochlear fluid. Our observations show further that this increase of fluid pressure does not interfere with the functioning of the sensory cells of the organ of Corti.

Since we fail to find any evidence of deafness as a result of an increase of perilymph pressure, it is obvious that we cannot expect a relief of deafness from a reduction of such pressure. These results, therefore, fail to support either the pressure theory of otosclerosis or the decompression theory of the effects of fenestration. The improvement of hearing that follows fenestration of the vestibular labyrinth is not a result of a reduction of fluid pressure, but must be accounted for in some other way.

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SOME SUGGESTIONS FOR SPEECH RECEPTION TESTING

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OF THE many abilities possessed by the human ear, one is of prime biologic and social importance. That is the ability to hear the human voice. Many writers have pointed out the nice correspondence between the physical dimensions of speech and the stimulus regions to which the ear is most sensitive. Designers of hearing aids strive first and foremost toward improved intelligibility of speech. The American Medical Association gives speech reception exclusive consideration in its notation system for auditory deficiency.

In spite of this emphasis on speech, however, the actual clinical testing for speech reception at the present moment lags far behind the testing for reception of other kinds of sound. In reliability and validity the procedures for testing reception and discrimination of pure tones, or of bands of noise, are both superior to the usual procedures for testing speech reception.

This does not mean that reception of speech for some reason cannot be measured as accurately as reception of any other type of sound. It does mean that methods of testing speech reception with satisfactory precision are peculiarly slow to diffuse from the experimentalist to the clinician.

Accurate and rapid assessment of speech reception is now possible for the up-to-date clinician. Yet, today, the traditional free voice test, with its many inherently unreliable aspects, is still commonly used in clinics and private offices over the country and is almost universally used in our huge military establishment. There are, indeed, few centers which test speech reception in any other fashion.

The purpose of this article is to present suggestions for those who wish to improve their testing for ability to hear speech, and perhaps to attempt their own standardization of one or more of the newer laboratory tests.

THE PROBLEM

Theoretically, the free voice test is based on the law of inverse square, which states that sound pressure decreases as the square of the distance. The tester stands, let us say, 15 feet (4.5 meters) from

From the Medical Research Laboratory, Submarine Base. The opinions expressed are solely the author's, and do not necessarily reflect official Navy policy.

the ear under examination and speaks at such an intensity that a normal ear would just hear the words. The voice is to be kept at this same intensity throughout the test, if the patient does not respond, the tester moves nearer to repeat the phrases, trusting in the reduced distance to make his voice louder at the patient's ear.

The most obvious shortcoming of this procedure is that in the usual testing alley as the tester moves toward the patient the law of inverse square does not cause the tester's voice to get much louder to the patient. The increase of intensity is so slight for the first 13 feet (4 meters) that that alley distance is effectively wasted. At a distance of only 6 inches (15 cm) from the patient's ear, the tester's voice is only 15 decibels louder than if the distance between voice and ear were the full 15 feet (4.5 meters). Obviously, if no other factor than distance were present in the usual free voice test, only normal-hearing or very slightly deaf ears could ever be accurately tested.

What actually happens in most free voice testing is that the tester varies the intensity of his voice within wide limits. His supposed dependence on distance is mostly illusory.

An experienced tester will, from necessity, dispense almost entirely with distance as an aid in controlling intensity, and attempt to regulate the intensity of his voice as it leaves his lips. As he approaches the deafened patient from the initial 15 feet, he uses a more and more intense voice. An analysis of the published reports of one vastly experienced clinician revealed that the voice intensity increased logarithmically while the testing distance decreased arithmetically.¹

With this particular clinician, when a patient received a voice score of 20 feet (6 meters) a voice intensity was used which a normally hearing person could hear at 43 feet (13 meters), but when a patient received a voice score of 1 foot (30 cm) a voice intensity was used which a normally hearing person could hear at 2,015 feet (614 meters). These limits, between a low whisper and a loud shout, are manifestly necessary for testing slightly, moderately and severely deafened ears, but the accurate production of such a range of voice intensities is difficult. From this difficulty stems most of today's dissatisfaction with the free voice test.

The problem, then, is to find a quick, reliable method of controlling the intensity of speech at the patient's ear. We have seen that the law of inverse square offers limited help, and that intensity of speech at the tester's lips must be controlled over such a range that only the most experienced clinicians can hope, in the traditional form of the test, to attain a usable level of reliability.

¹ Harris, J. D. Free Voice and Pure Tone Audiometer for Routine Testing of Auditory Acuity. Studies on Comparative Efficiency [fig. 1], *Arch Otolaryng* 44:452-467 (Oct) 1946.

Recent research has attacked this problem from three directions (1) by using a sound level meter to aid testers in controlling their voice intensities, (2) by using a microphone-amplifier-loudspeaker network to present the speech, with variable resistance to control final voice intensities at the patient's ear, and (3) by using the same network, but with a phonograph pickup substituted for a microphone. These three approaches will be considered in order.

Use of the Sound Level Meter —An instrument which is extremely useful for research and testing in audition is an electronic device, the sound level meter, which indicates in clear physical units the sound pressure at its microphone. Sound level meters are now easily obtained commercially and are simple to use. One model, which meets all requirements of the American Standards Association, can be slipped into the coat pocket.²

Dr. E. P. Fowler, Jr. first recognized the possibility that the sound level meter could be used to investigate the free voice test.³ The instrument, particularly if it has a highly damped needle, so that the intermittent irregularities of the intensity of normal speech are somewhat smoothed out, will enable the tester to adopt a relatively constant level of speech intensity or to change it by definite amounts. The error involved will be considerably less than that involved in the traditional procedure, in which the tester regulates speech intensity by himself listening to the sound of his own voice.

The use of a handy portable instrument to place and vary the intensity of one's voice would seem the minimum equipment necessary for the testing of speech reception. Fowler had demonstrated that the distance at which a sample of typical speech tests could just be heard varied up to 200 per cent. Such a variation, which makes absurd any fine interpretation of free voice scores, would tend not to occur if the sound level meter were properly employed.

(It may not be out of place here to indicate the great value this instrument can have in defining another important variable in speech reception testing, namely, the amount of ambient noise in the testing room. A quick glance at the meter placed in the position usually occupied by the patient's head and read during typical testing hours will do much to determine the suitability of that room for such work and will materially improve the interpretation of data taken under those conditions.)

² This model is available from Hermon Hosmer Scott, Inc., 385 Putnam Ave., Cambridge, Mass.

³ Fowler, E. P., Jr. The Discovery and Evaluation of Otic Cripples, *Arch Otolaryng* 45:550-561 (May) 1947.

In using the meter to standardize one's own free voice test, the tester stands at a convenient distance from a normally hearing patient, say 15 feet, and regulates his voice so that the patient can just repeat the phrases. The average reading of a broad sample of speech at that intensity is noted from the meter, placed about 2 feet (60 cm) from the tester's lips and to one side. This is repeated for perhaps a dozen normally hearing patients, and the final average reading determined. Then, with the tester, meter and patient in the same positions in the room, the tester can, by watching the meter, produce a voice intensity which can just be heard by the average normal ear. If the patient cannot respond correctly to that intensity, he is "hard of hearing" for speech. Next, the extent of his deficiency is quickly determined with further use of the meter, as follows. The tester raises his voice until the patient does begin to respond correctly. At that intensity the tester presents speech samples until he has confidence in the reliability of an average meter reading. Then, quite simply, the hearing loss is the difference in decibels between that reading and an average reading for normally hearing persons taken under the same standard conditions.

The unit used here, the decibel, has come to be the only notation used by all communications engineers, psychologists, physiologists and some otologists to describe speech intensity levels. It is the unit used in all pure tone audiometry. There seems little doubt that in the field of speech reception testing it will quickly supplant the archaic distance fraction among forward looking clinicians interested in reliability and precision of statement. If an otologist should report that a certain patient is so many decibels deaf than normal for ordinary speech, he will be certain to be understood by most readers. If necessary, a table converting decibel loss to distance fraction can be used, thus, the values of both scales may be secured.⁴

The foregoing discussion showing how the sound level meter can be used as an important adjunct of the free voice test does not imply that all difficulties inherent in the traditional test are overcome. Problems of masking, of inherent differences of intensity of speech sounds, of the selection of proper speech items, etc., are still present in this as in any other speech reception test. Nevertheless, one detrimental source of variation, namely, random fluctuations of over-all speech power, is controlled to a good extent.

The Monitored Live Voice—One difficulty of using the sound level meter is that the tester must learn to speak at a fairly constant level

⁴ Harris, J. D. Interpretations of Measurements of Auditory Threshold, in *Encyclopedia of Vocational Guidance*, New York, Philosophical Library, Inc., 1947, vol. 1, pp. 443-445.

at any one of a wide variety of levels depending on the acuity of the patient. This is easier said than done. Moreover, speaking either very softly or very loudly tends to distort the speech sounds.

To eliminate this difficulty, one may substitute a high fidelity communication system between tester and patient, locating the patient in another room so that he cannot hear speech directly from the tester's lips. This procedure has been used most extensively by the Bell Telephone Laboratories⁵. The system will amplify ordinary speech even beyond the loudest shout of which the tester is capable. By simply changing a resistance dial calibrated in decibels, the tester can transform any phrase he utters, always at the same effortless intensity, into a very weak or a very loud sound. The tester monitors his speech by watching a meter. A simple talkback switch allows him to record the patient's response, if any. As with the sound level meter, hearing loss for speech is described as so many decibels below that of normal subjects.

A communication system adequate in all respects costs no more than a good radio, perhaps \$200 to \$300, and can be installed by any radio repairman. Indeed, the components of a good radio-phonograph can easily be reassembled and used for the purpose. The only extra equipment needed is a microphone, a wattmeter to monitor the speech intensity at the tester's lips, and a resistance dial worked in decibels to control the final intensity at the patient's ear. Figure 1 shows how the equipment may conveniently be laid out, with suggestions about each component part.

The monitored live voice test is conducted in almost exactly the same way as the traditional free voice test. The tester speaks at constant intensity, watching his wattmeter the while, and changes his resistance dial until the patient begins to respond correctly. At that point, the hearing loss for speech is calculated as the difference in decibels between the resistance dial for that patient and the dial setting for known-normal ears.

The patient may respond through a talkback system—this may simply be a pair of interoffice squawk boxes—or, in some cases, as with children or those of low intelligence, a normally hearing assistant may sit beside the patient and record responses.

It may thus be seen that the monitored live voice system preserves all of the advantages of speed and flexibility of the traditional free voice test. In addition, it provides a much superior method of varying speech intensity at the patient's ear.

The superiority of the monitored live voice test can easily be shown statistically. Under routine administration, the traditional spoken voice

⁵ Fletcher, H. *Speech and Hearing*, New York, D. Van Nostrand Company, Inc., 1929.

test will have almost no reliability,⁶ while under the same routine conditions the monitored live voice test has a test-retest reliability of about ± 0.70 , or very nearly as good as that of routine pure tone audiometry.⁷

It is true that an experienced clinician in his free spoken voice test can do considerably better than is usually found under routine testing, on the other hand, he can also improve on the routine reliability of the monitored system.

It would seem that with electronic control of intensity levels, speech reception testing has been put on a firm basis. With the use of this equipment, any alert clinician can learn to test the speech reception of "hard of hearing" patients with a precision hitherto unobtainable.

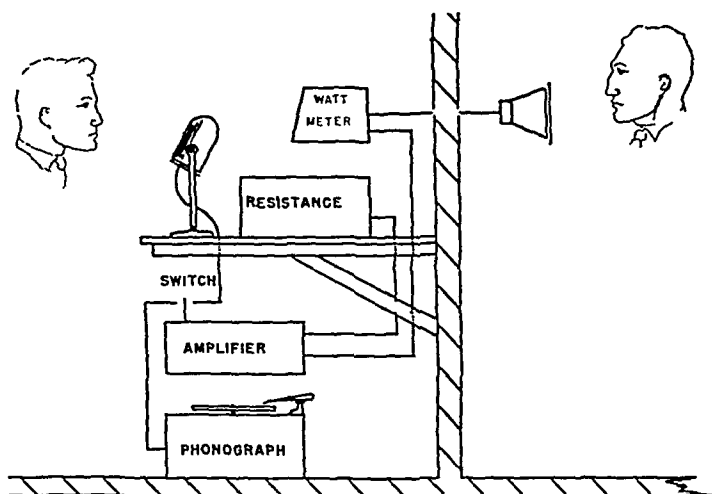


Fig 1—Equipment arranged for the testing of speech reception. The phonograph pickup, the microphone, the amplifier and the loudspeaker must be of such quality that ordinary speech seems quite natural to a normal-hearing person at the patient's position. Such a check is quite sufficient. Specifically, little or no distortion should occur between 100 and 4,000 cycles per second. Such units can be purchased at any radio store. The wattmeter, which multiplies volts times amperes, and the resistance box, which should contain 110 decibels in steps of 1 decibel, can be purchased from Daven Company, 191 Central Avenue, Newark, N. J.

The Phonograph Voice—There remains, however, another important tool which the clinician must use if he wishes to approach laboratory precision. This is to substitute a phonograph pickup for the microphone in the monitored live voice equipment. This may simply be done by means of the two way switch shown in figure 1.

⁶ Shilling, C. W., Everley, I. A., and Harris, J. D. Hearing Tests An Evaluation, U. S. Nav. M. Bull. 44 100-116, 1945.

⁷ Carhart, R. Monitored Live-Voice as a Test of Auditory Acuity, J. Acoust. Soc. America 17 339-349, 1946.

It might seem at first glance that using the phonograph voice rather than the actual voice is a step in the wrong direction. A certain amount of tester-patient rapport is lost, speed of presentation is inflexible, one is limited in choice of records, etc. Nevertheless, the recorded voice has definite advantages with a patient for whom the phonograph technic is appropriate. It is easier, it can with more confidence be turned over to assistants, test-retest results are more stable, and a record can be analyzed word by word.

A more basic advantage, however, of the recorded voice is that, by a rerecording technic, the individual words of any particular sample of speech sounds may be rendered very nearly alike in intelligibility. This likeness, or homogeneity, of intelligibility can never be achieved so well with either the free or the monitored live voice because of the wide difference in the relative intelligibility of words, some words being inherently much more easily understood than others—even though all words are produced at the same physical intensity.

In order to understand why homogeneous intelligibility is desirable, it will be helpful to refer to figure 2. On the baseline is found a scale of intensity levels, and on the vertical is found the percentage of words correctly heard. At more intense levels, toward the right of the figure, more words are correctly heard. A curve describing the increase in words correctly heard as the speech becomes louder is known as an "articulation curve" or "articulation function."

Figure 2 presents articulation curves for two lists of words. Both lists have been read by one speaker over the same communication system to the same subjects. After every 5 words, the intensity was increased 5 decibels, until all subjects reported most words correctly. One wishes to know, now, at what intensity these subjects could repeat 50 per cent of the words. (The 50 per cent point is adopted as a simple convention so that any patient's speech reception may be compared with a normal standard.)

It is plain from figure 2 that list A, with quite good homogeneity, defines these patients' 50 per cent point with slight experimental error. List B, on the other hand, defines the 50 per cent point with much greater error. Evidently, with words such as those in list A, only a few would be needed to assess the patients' speech reception, on the other hand, because of the inherent variability of intelligibility of the words in list B, many more words would have to be presented to reach comparable precision as to the patients' 50 per cent point. If more words are presented at each level, the irregularities from level to level will average out, and the curve in figure 1 for list B might smooth out so that the 50 per cent point is fairly unequivocal. But the presentation of these additional words costs more time and effort than most

clinics can afford, and in any case the curve for list B will never change its slope so that it approximates the steep slope for list A

The conclusion is plain that homogeneous intelligibility, represented by as steep a slope as possible for data plotted as in figure 2, is one of the major goals to be approached in the testing of speech reception

(a) Relation Between Intensity of Speech and Its Intelligibility

In their first experience with the monitored voice, clinicians are surprised that of two words which deflect the meter alike, one is clearly intelligible, the other not at all intelligible. Yet over-all intensity is only one of many factors contributing to intelligibility. Among these other factors are the relative intensity and temporal pattern of com-

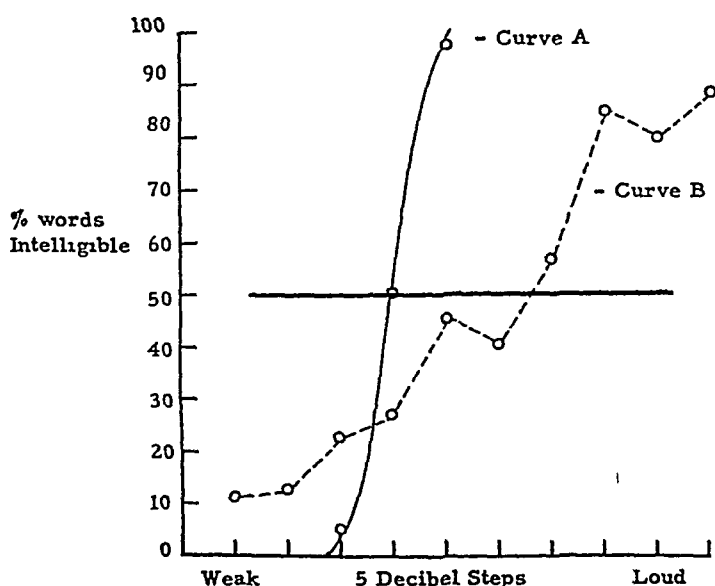


Fig 2—Effect of homogeneous intelligibility on precision of speech reception tests. *Curve A* Words in this list are ideally homogeneous in intelligibility, the intensity at which 50 per cent are correctly heard is found with only slight error. *Curve B* Words in this list are less homogeneous, the intensity at which 50 per cent are intelligible is found with much greater error.

ponent sounds, familiarity of vocabulary, differences of dialect, and others too numerous to mention.

It is obvious, of course, that a weak speech sound which is unintelligible can usually be made intelligible merely by increasing its intensity, in this sense the intensity of a speech sound and its intelligibility have the most direct relationship. But the characteristics of speech which go to make up its intelligibility are so many and complex that in any group of sounds one cannot tell which is the most and which the least intelligible word merely by knowing the most and the least intense.

The fallacy, then, in the use of the sound level meter or of any monitoring device lies in the assumption that if one can only make

all words equal in intensity those words will be equal in intelligibility. But within the intensity limits of ordinary speech that is not fully true.

A brief experiment well illustrates this point. A 50 word monosyllable list was recorded. This record was then analyzed for relative intelligibility, word by word, as follows. It was played over high quality head phones to a dozen normally hearing subjects at once, at such an intensity that only a few subjects could write down one or two words correctly. The intensity was then increased 5 decibels, and the whole list played over again. This process was repeated several times, each time the intensity being increased 5 decibels, until all sub-

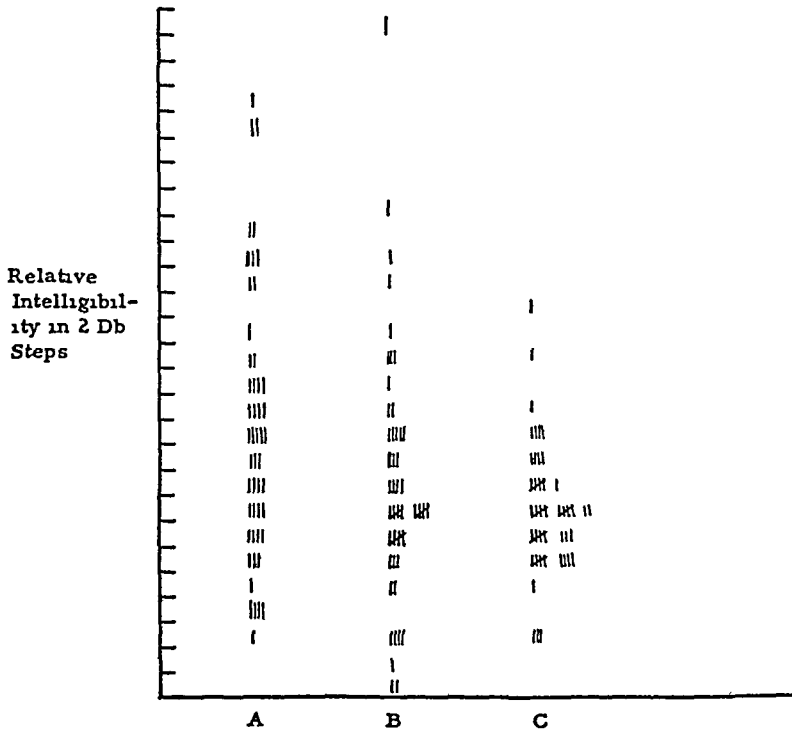


Fig 3—Frequency distributions of relative intelligibilities of 50 monosyllables under three conditions *A*, Harvard phonetically balanced (PB) list 1, original recording; *B*, same list recorded for homogeneous intensity; *C*, same list recorded for homogeneous intelligibility.

jects were writing almost all words correctly. Then, for each word, the intensity was found at which 6 (i.e., 50 per cent) of the men wrote that word correctly. From these data one can state that a certain word would have to be, say, 8 decibels louder before it becomes as intelligible as the average word. Each word was thus assigned a relative intelligibility in terms of its intensity in decibels at the 50 per cent intelligible point.

The relative intelligibilities of all words in this particular recording may be found in column 1 of figure 3. It is seen that a range of

42 decibels exists between the easiest and the hardest word to understand, with a standard deviation (within which two thirds of the words should fall) of ± 10.5 decibels

Now, according to the assumption that intensity and intelligibility of speech are identical, one could reduce this extreme scatter of intelligibility if only some technic were at hand to make the original words more nearly alike in physical intensity. This was done by measuring the intensity of each word on a high speed paper tape recorder. Then, in a rerecording, the intensity of each word was changed toward the average by adding or subtracting resistance in the recording circuit.

What, now, has happened to the relative intelligibilities of the words in this second record? These have been calculated from a new group of 12 normally hearing subjects, and appear in column 2 of figure 3. The range of relative intelligibility, far from being reduced, has increased to 51 decibels, though the standard deviation has increased to only 10.55 decibels. Evidently, equating the relative intensity of words of a list of monosyllables does not have too much effect on the scatter of their relative intelligibilities.

For normal speech levels, then, one concludes that the relationship between intensity and intelligibility is obscured by the operation of other variables and that more homogeneous intelligibility must be sought by other means.

(b) Homogeneous Intelligibility Obtained by Selecting Words. It is possible, of course, to obtain homogeneous intelligibility by choosing a series of test words which have that characteristic. Polysyllables are more homogeneous than monosyllables, and steady, even-toned sentences are best of all, since intelligibility of such sentences is a sort of average of more speech sounds.

Hudgins and his colleagues⁸ used the word selection technic to good advantage. They provided explicit directions for using the phonograph in a speech reception test and recommended a set of records consisting of scramblings of a master list of 84 spondee (bisyllables, both syllables accented). Analysis of one of these records, containing 72 words, reveals a spread of only 13 decibels between the least and the most intelligible word. This is considered very good when compared with similar data for unselected words.

May one not, then, unreservedly recommend these 84 words for all speech testing, whether the lists are used with the sound level meter, read over a monitoring system or given by phonograph?

⁸ Hudgins, C. V., Hawkins, J. E., Karlin, J. E., and Stevens, S. S. The Development of Recorded Auditory Tests for Measuring Hearing Loss for Speech, *Laryngoscope* 57: 57-89, 1947.

One would wish to do so and thus solve at once many besetting problems. Unfortunately, it appears that in striving for homogeneous intelligibility the authors were forced to neglect the fact that their final list is far from representative of American phonemes. Thus their records, while admirable in conception and quality, must be regarded as stepping stones to further lists that reflect useful compromises among the several desiderata.

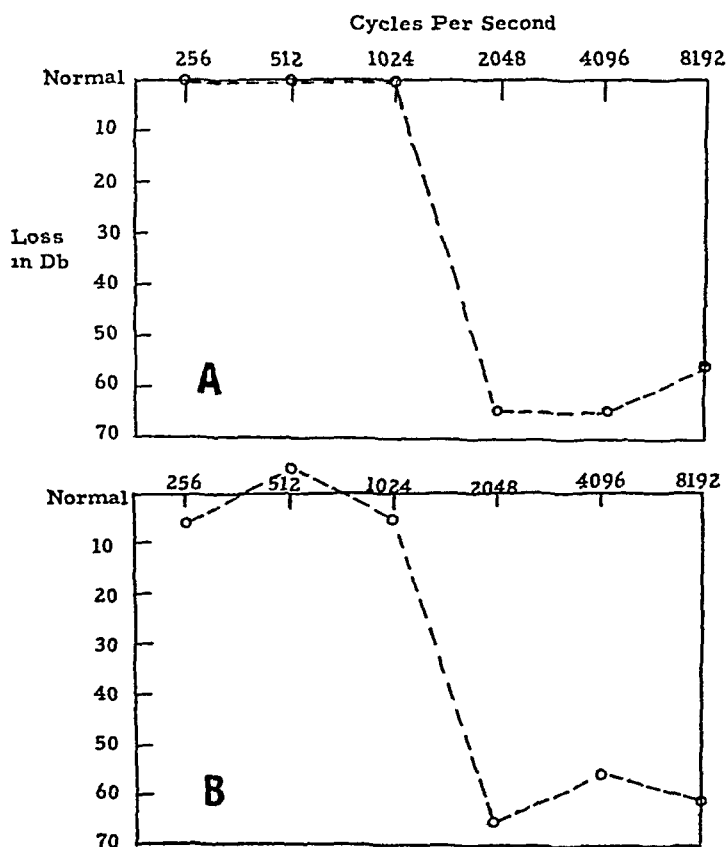


Fig 4—Slight effect of extreme deafness for tones above 1,000 cycles per second on intelligibility of spondees. *A*, audiogram of the right ear of patient J E H, whose acuity of hearing for words was 65 decibels below normal (spondee records 2 A and 2 B). *B*, audiogram of the right ear of patient H L S, whose acuity of hearing for words was 117 decibels below normal (spondee records 1 E and 2 A).

Specifically, it appears possible for a person to understand almost all 84 words perfectly even though he is profoundly deaf above 1,000 cycles per second (cps). Proof of the statement is contained in figure 4 *A* and *B*, showing the audiograms of 2 persons for whom these words were nearly as intelligible as for normal subjects.

Another line of evidence on this point comes from a study in which complete deafness above 1,000 cps was simulated in normal ears.

The spondees spoken of in a foregoing paragraph were played to 12 normally hearing subjects, and a typical articulation curve was drawn. This is curve A in figure 5. Next, these same spondees were played to another group of 12 normally hearing subjects exactly as before except that a filter passing only the frequencies of 1,000 cps and lower was inserted in the communication system. The resultant articulation curve is curve B in figure 5. There it will be seen that even with the severe frequency limitation the subjects nevertheless could understand at least 75 per cent of the words.

It seems clear that these spondee lists sample hearing of relatively low tone, especially, and that they do not indicate adequately deficits in the middle and high frequency regions of speech. Yet there must be

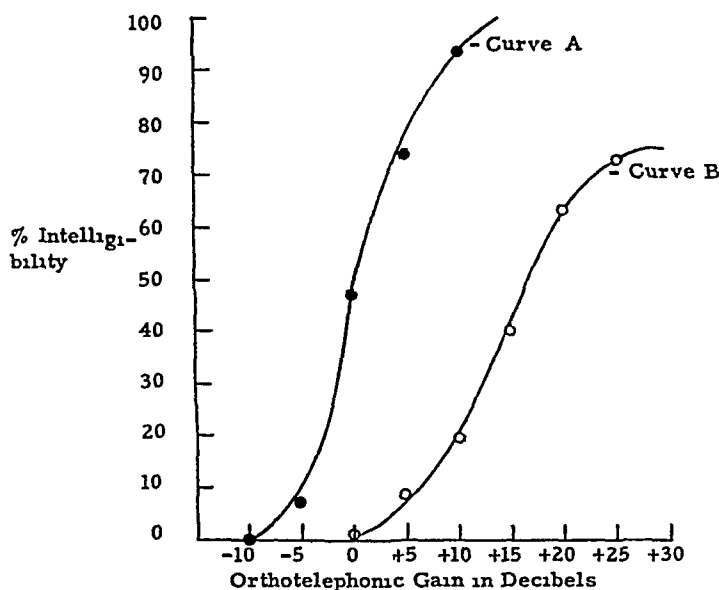


Fig 5—This chart shows ability to understand spondees even with extreme simulated high tone deafness

NOTE Speech played over a communication system at an orthotelephonic gain of 0 decibels will sound as loud to the patient as if the talker were speaking to him directly through the air at a distance of 1 meter

A, articulation curve of spondee list 1 A, recorded in this laboratory and presented by phonograph to 12 normal-hearing subjects. A white noise (i.e., all frequencies present and all at the same physical intensity) was mixed with speech B, articulation curve of the same record, presented to another group of 12 subjects. The same intensity of white noise was used. To simulate high tone deafness, a filter eliminating all frequencies above 1,000 cycles per second was inserted.

good acuity at these higher frequencies if speech in some situations is to be understood

In cases in which the audiogram is known to be fairly flat, so that all frequencies through the speech range are heard equally well or equally poorly, there is no question but that these records provide an

adequate check on speech reception⁹ But with other types of audiograms they may be to some extent misleading

The second approach, the use of connected discourse, reported by Falconer and Davis,¹⁰ has much to commend it The patient listens to steady speech and turns his own intensity dial until the sense is just apparent A transcription of one of Fulton Lewis Jr's radio talks is recommended for its evenness of tone and simplicity of expression A patient's reception of speech can be assessed quickly and easily There seems no reason why a small library of records could not serve to test a wide variety of types of patients—children as well as adults So far, no analysis of the frequency regions which carry the sense of these records has been made It may be, of course, that any one of several relatively narrow frequency bands could, because of the strong psychologic tendency to fill in, serve to render the passage intelligible If so, the analysis by this test of the functional status through the whole speech range of the patient's ear would be to that extent incomplete

(c) Homogeneity Obtained by a Rerecording Technic Here a third method of securing homogeneity—by phonograph rerecording—may be considered in detail Suppose that one records a list of words and analyzes each word for relative intelligibility as described in the foregoing pages Now suppose that on a rerecording one equates directly that which one wishes equated, namely, intelligibility The amount by which each word should be raised or lowered during the rerecording is found from the first analysis

When this technic is applied to the original record of figure 3 (it will be recalled that the vertical dimension shows relative intelligibility), it can be seen from column 3 of that figure that the scatter of relative intelligibilities has been greatly decreased The range has shrunk from 42 to 26 decibels and the standard deviation from 10.5 to 5.04

Evidently, equating the relative intelligibilities within a list of monosyllables has a marked effect, as in logic it should, and it is to that extent a useful tool in dealing with speech reception But notice that the technic cannot be utilized by any system such as a sound level meter which can equate only intensity What one wishes to obtain is not equal sound intensity at the patient's ear but equal intelligibility at the patient's brain, and for otherwise unselected speech sounds this can be directly obtained only with the recorded voice

(d) An Effort to Use the Rerecording Technic in Speech Reception Testing From all the foregoing considerations one concludes that two

9 Thurlow, W. R., Silverman, S. R., Davis, H., and Walsh, T. E. A Statistical Study of Auditory Tests in Relation to the Fenestration Operation, *Laryngoscope* 58 43-66, 1948

10 Falconer, G. A., and Davis, H. The Intelligibility of Connected Discourse as a Test for the "Threshold for Speech," *Laryngoscope* 57 581-595, 1947

major requirements of a speech reception test, (1) representativeness in sampling speech sounds and (2) homogeneity of intelligibility, can be secured by the following steps

- 1 Selecting a group of words which does form an adequate sample of English speech sounds
- 2 Recording this list with high fidelity
- 3 Determining the relative intelligibility of each word
- 4 Rerecording, compensating for each word so that the relative intelligibility of all words tends toward an average

Such a list of recorded words could be used in testing with about the same precision as the spondee lists of Hudgins and associates and should have somewhat greater significance for hearing deficiency in the middle and higher speech frequency ranges

In this laboratory my associates and I have tried to follow the steps outlined, with some degree of success

Our choice of words was dictated by practical as well as theoretic considerations. Theoretically, the ideal way to achieve adequate representation of speech sounds is to use the sounds alone or combined in two letter or three letter nonsense syllables. This device was employed in the classic researches of Fletcher and his associates. It demands, however, careful training in the use of the phonetic alphabet, so that with clinical patients it is out of the question. The next best thing is to use a number of monosyllables commonly found in ordinary conversation. There are enough of these so that one can include all the elementary sounds and combinations of sounds, yet have the words meet the requirement of familiarity to the patient.

Note that polysyllables should not be used, because a "hard of hearing" patient, defective in one frequency region of the speech range but normal in other regions, can often understand a partially unheard word by a psychologic filling-in process. In this case his deficiency would remain undiscovered.

A list of monosyllables has been constructed which fairly meets the requirements of representativeness and of familiarity. These are the so-called Phonetically Balanced (PB) Lists of Harvard University.¹¹ Twenty lists, of 50 common monosyllables each, were so constructed that each list has about the same total phonetic composition as every other list, and each one was designed to have as closely as possible the same proportions of speech sounds as occur in ordinary conversation. These 1,000 words form an invaluable repository of items for certain kinds of speech reception testing.

¹¹ Egan, J. P. Articulation Testing Methods, *Laryngoscope* 58 955-991, 1948

These 20 lists were all recorded in this laboratory with high fidelity. In order to sample speech as it is actually heard, each list was recorded by the male spoken voice, the female spoken voice and the female whispered voice. Four males and four females were used. These 60 records form a basic library for phonograph speech reception testing.

Our first concern was whether the phonetically balanced (PB) monosyllables did sample hearing at frequencies above those necessary for understanding the spondees. If this were not the case, the PB lists would have no superiority whatever over the spondee records of Hudgins and associates, which are otherwise ideal.

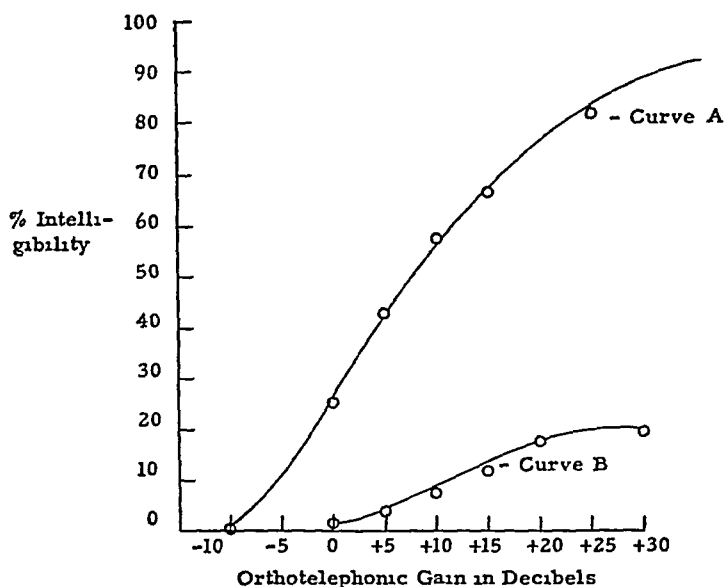


Fig 6—This chart shows inability to understand phonetically balanced (PB) lists with extreme simulated high tone deafness. *A*, articulation curve of PB list 1, recorded in this laboratory and presented by phonograph to 12 normal-hearing subjects. The same white noise was mixed with the speech as in figure 5. *B*, articulation curve of the same record, presented to another group of 12 subjects. The same intensity of white noise and the same filter were inserted as in figure 5. NOTE: White noise is mixed with the speech because the filter used does not discriminate infinitely. A 45 decibel differential exists between frequencies passed and those suppressed. White noise effectively eliminates these unwanted frequencies from the problem.

The following experiment clearly demonstrates the superiority of the PB lists on this point. Several spondee lists and several PB lists were recorded in one session, using the same voice, the same voice intensity and the same recording amplifier setting. Each record was then played to one of several groups of 12 men each, either with or without a 1,000 cps filter in the circuit. Results for the spondees have already been presented in figure 5. Results for the PB lists are presented in figure 6. Curve *A* shows the articulation function

before filtering, while curve *B* shows the function after filtering which simulates complete deafness above 1,000 c p s. Figure 5 shows that such simulated deafness reduces spondee intelligibility by only 25 per cent, while figure 6 shows that the same deafness reduces PB intelligibility by 80 per cent.

Thus it is clear that the PB lists do sample speech sounds in the higher frequency regions.

Our second concern was whether, by rerecording, the desirable feature of homogeneous intelligibility could be obtained as well for the PB lists as for the spondees. For this purpose we wish to compare the two types of material with respect to the slope of the articulation curve.

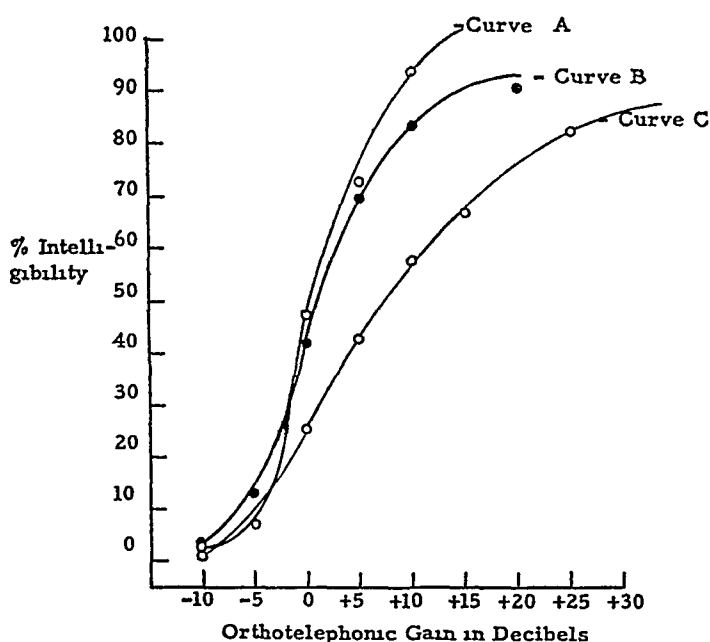


Fig 7—This chart shows that rerecording for homogeneous intelligibility can render a list of words about as homogeneous as a list of words preselected for that characteristic. *A*, articulation curve of spondee list 1A, recorded in this laboratory; *B*, articulation curve of PB list 1, rerecorded for intelligibility; *C*, articulation curve of PB list 1, from which the record of curve *B* was derived.

It will be recalled from figure 2 that the steeper the slope, other things being equal, the better the test for speech reception.

A selection of PB records was analyzed, record by record and word by word, for relative intelligibility. Rerecordings were then made, making poorly intelligible words louder and easily intelligible words weaker, so that a closer central tendency was achieved. These records were then presented to new groups of normally hearing subjects, and the success of the rerecordings was assayed.

It appears that the rerecording process is distinctly of value in rendering a list of words more homogeneous in intelligibility. Figure 7 shows

for a typical list the change in slope of the articulation function before and after rerecording. The steepness of the slope comes to approach that of the spondee records, also reproduced in figure 7 for comparison. Thus the time and the effort spent are justified.

The technic by which these records may be used for speech reception testing is exactly that described by Hudgins and associates for the spondees. A carrier sentence, "Number 1 is _____," "Number 2 is _____" precedes every word. Seven seconds elapse between items, during which the patient writes or speaks the test word. After every tenth word, 5 decibels of resistance are introduced so that the next 10 words are 5 decibels weaker. A test tone is cut on the record so that with a voltmeter the examiner can assure himself that the intensity level is constant for successive tests. The level at which several normal subjects miss half of the 10 words at that level can be found, and any patient's loss can easily be expressed as the number of decibels by which his hearing of speech differs from that normal standard.

It is to be hoped that some of the PB lists, suitably rerecorded and standardized, may one day be commercially available. The labor involved in recording one or two lists, determining the relative intelligibility of each word and rerecording, is not great if the help of a recording studio or a local radio station is enlisted, as can often be the case. Such records, the precision of which could be depended on even when they are in the hands of a nonmedically trained assistant, would be a welcome adjunct to the armamentarium of the busy otologist.

SUMMARY AND CONCLUSIONS

This paper on the testing of speech reception is designed to assist the clinician who wishes to supplant the unreliable free voice examination with one of the newer tests using the helpful tools of electronics.

In the traditional free voice test the most distressing source of unreliability is the random fluctuation of over-all speech intensity. Directions are given for controlling this variable with a handy portable instrument, the sound level meter, and for reporting hearing deficit in terms of decibels below normal, rather than in terms of the relatively meaningless distance fraction.

A further modification, which inserts a high fidelity communication system between tester and patient, is described. Its advantage is that the tester monitors his voice and need speak at only one level throughout. Very loud and very weak speech are produced by amplification and attenuation.

A fallacy of the monitored live voice test is shown, in that equal intensity of two words at a meter is not necessarily the same thing as equal intelligibility at the brain. Yet equal intelligibility of test words

is one of the two most desirable characteristics of a word list for speech reception testing

Equal intelligibility can be achieved by selecting words to that end. The best speech reception test so far available, that of Hudgins and his colleagues, offers a set of phonograph records with words of extremely homogeneous intelligibility. It is shown, however, that these words lack another necessary characteristic for an ideal test. They are not representative of speech sounds. They can, indeed, be heard quite well by a patient with serious hearing deficit in the upper half of the speech frequency range. They may therefore be considered to test speech acuity only in the lower speech registers.

The twenty Harvard Phonetically Balanced Lists, of fifty monosyllables each, on the other hand, fairly meet the requirement of representativeness. But the words within each list are inherently very different in intelligibility. The two requirements considered here, of representativeness and of homogeneity of intelligibility, can, however, be secured. A phonetically balanced list, which meets the first requirement, may be treated in rerecording technic so that the second requirement likewise is attained.

This laboratory has prepared a number of such records, and offers directions for and testimony to the worth while nature of the technic.

Mr. C. K. Myers supervised the recording and collected all data reported here.

VIRUS VACCINE IMMUNIZATION AGAINST THE COMMON COLD

NOAH FOX, M D
AND
GEORGE S LIVINGSTON, M D
CHICAGO

THE IDENTIFICATION of the various types of infections of the upper respiratory tract is difficult, because complete bacteriologic differentiation is not yet possible. Definition through establishment of clinical criteria is even more difficult, since objective signs and subjective symptoms are unreliable guides.

Dingle¹ has identified two types of the common cold which are distinct entities: the one, a coryzal type, with an incubation period of one to two days, and the other, a pharyngeal type, with an incubation period of three to nine days. However, he stated that "without knowledge of the incubation periods, the illnesses in a few of the volunteers in each group could not have been differentiated with certainty."

We have not been able to differentiate either spontaneous or induced colds on the basis of clinical characteristics or incubation periods. During the same epidemic, and in the same household, we have noted mild symptoms in some members of a family and severe symptoms in others. We have also noted that usually the person who suffers from severe cold symptoms does so consistently for a period sometimes of several seasons and then enters a period during which he has fewer and milder colds, a pattern apparently indicating a change to the hypoallergic state. Attempts to differentiate the common cold from true influenza on the basis of symptoms, that is, severity and complications and the like, have not been reliable, because a severe cold frequently has the same clinical pattern as influenza.² It must be kept in mind that other investigators have reported influenza-like epidemics in which they have been unable to demonstrate the virus of either the A or the B type of influenza.³

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1 Dingle, J. Experimental Studies of the "Common Cold" in Human Volunteers, *Tr & Stud, Coll Physicians, Philadelphia* **15** 113, 1947.

2 Smillie, W G. Symposium on Infections of the Respiratory Tract, *New England J Med* **223** 651, 1940.

Illustrative of the differences in colds induced by the same agent are the variable results noted in one of our transfer experiments. Six volunteers were inoculated intranasally with chorioallantoic fluid from chick embryos, in which nasal washings from a subject with a mild cold had been propagated for forty-eight hours. One volunteer, with old intrinsic asthma who was selected for her high susceptibility to colds, had a chill within six hours, with development of a very severe infection of the upper respiratory tract, terminating in bronchopneumonia. This patient's illness was ushered in by a high fever, chill and general body aches and pains, symptoms attributed to influenza. In a second volunteer, also with a rather severe perennial nasal allergic condition and a high susceptibility to colds, there developed a very severe infection of the upper respiratory tract, which progressed to purulent sinusitis, but which was also ushered in by increased temperature, chills and general body pains, such as occur in influenza. His symptoms had their onset within twelve hours after inoculation. Two volunteers, also susceptible to colds, had very mild colds, without a rise in temperature, after twenty-four hours, but recovery was uneventful within five and six days, respectively. The third pair of subjects, inoculated with the same material, did not have colds.

We have found, as have others, that there is a general tendency for colds to occur in epidemics of varying patterns, although they may occur sporadically throughout the cold months. Except when secondary infection occurs, the common cold lasts from four to six days. It can be transmitted to volunteers during any period of its course, although more "takes" occur during the first twenty-four to forty-eight hours. Little faith can be placed in a patient's account of a cold. The diagnosis must be made by a competent observer, who is able properly to examine the nose and throat and evaluate the physical findings. This is especially important because so many cold-susceptible patients also suffer from attacks of hyperesthetic rhinitis, the symptoms of which simulate an early cold.

We have made careful subjective and objective studies of colds during every epidemic since 1932. From these studies we have pieced together a general pattern of symptoms and signs to guide us in the identification of this disease. The common cold may begin with either

3 (a) Reiman, H. A., and Stokes, J., Jr. An Epidemic Infection of the Respiratory Tract in 1938-1939, *Tr. A. Am. Physicians* 54:123, 1939. (b) Allen, W. H. Acute Pneumonitis, *Ann. Int. Med.* 10:441, 1936. (c) McKinlay, C. A. Acute Diffuse Bronchiolitis with Report of a Case, *Journal-Lancet* 50:90, 1939. (d) Reimann, H. A., and Havens, W. P. An Epidemic Disease of the Respiratory Tract, *Arch. Int. Med.* 65:138 (Jan.) 1940. (e) Magill, J. T. A Virus from Cases of Influenza-Like Upper Respiratory Infection, *Proc. Soc. Exper. Biol. & Med.* 45:162, 1940.

pharyngeal or nasal symptoms When it begins in the pharynx, the patient complains of a dry, painful sensation high up in the pharyngeal vault Examination of this area by direct view reveals acute inflammation of the mucosa At this stage there is some general lassitude but usually no fever or cough These symptoms last twenty-four to forty-eight hours, after which the infection moves either into one side of the nose or into the oropharynx When the nose becomes involved, the patient has a headache, usually on the same side as the nasal involvement, the nose becomes stuffy and there is present a feeling of irritation Examination of the nasal mucosa reveals the signs of acute inflammation After twelve to twenty-four hours, the opposite side of the nose becomes involved, a watery discharge is present and excoriation of the skin of the nasal vestibule and the upper lip occurs These symptoms last about three days, when the cold terminates, unless the infection spreads into the sinuses This complication occurs in persons whose local resistance to the virus is low—for example, the allergic person with hyperplastic changes throughout the upper respiratory tract When the sinuses first become involved, there is usually severe headache, and the nasal discharge still appears watery After the second or third day, however, definite secondary infection occurs, and the discharge becomes purulent There then develop the symptoms associated with acute purulent sinusitis—nasal discharge, pain and tenderness over the sinuses, postural headache, pharyngeal cough due to the postnasal drip, particularly during sleep, when the material accumulates in the pharynx, some rise in temperature, and an increased white cell count The severity of the latter symptoms depends on the number of sinuses involved On the other hand, the infection may begin in the pharyngeal vault and move down the respiratory tract without involving the nose or sinuses In these cases cough is an early predominant symptom and is often associated with hoarseness when the larynx becomes involved In most cases the infection is arrested in the larynx, the entire cold lasting from four days to a week In other cases the virus infection may move down into the chest, resulting in virus pneumonitis Secondary invaders may overgrow anywhere along the area, resulting in a purulent infection of the pharynx, larynx, bronchi or lungs

The common cold may begin in the nose instead of the pharynx, secondarily infecting the sinuses and the lower respiratory tract The symptoms and complications differ in no way from infections which are primary in the pharynx Both types are seen in the same epidemics, and even in members of the same families We have transferred the nasal type to human volunteers and have had primary pharyngeal infections develop We, similarly, have transferred material originally obtained from patients who initially had pharyngeal symptoms and have had the initial symptoms develop in the nose

Some clinicians⁴ have observed a similarity in pattern in each epidemic of colds, suggesting that a common virus agent is active in each epidemic. However, it would seem that the severe symptoms and complications noted in human subjects are associated with overgrowth of respiratory bacteria prevalent at the particular time that the virus epidemic occurs. Smillie² found *Pneumococcus* type XIV prevalent in an orphan home without serious consequence until an epidemic of colds invaded the nursery. The pneumococcus increased in prevalence in infections of the throat and ear, and pneumonia occurred. Pneumococci of type XIV were isolated from the ears and the sputum. Every rhinologist is familiar with the patient suffering from hyperplastic sinus disease who invariably has to seek help after the second week of a cold because of suppuration in the sinuses.

It is normal for persons to have one or two colds during the year. However, the sufferer from colds who seeks help from the physician is likely to have four or more colds yearly, each cold occurring during one of the numerous cycles of virus colds which occur almost monthly throughout the year. Not infrequently, particularly in children, these colds are so numerous that the patient continuously has a suppurative pansinusitis, which represents the residuum carried over from one cold to another. Such patients, it must be remembered, are physically normal, but if their noses are examined hyperplastic changes are found, indicating an allergic state. Our belief that patients with frequent colds are allergic rests on the further evidence of other allergies in the person and in his family, as well as on the evidence obtained by a survey with foreign proteins.

It must be appreciated, therefore, that of the numerous factors which predispose persons to colds, allergy is probably one of the most important—a factor long overlooked because the condition is not evaluated properly during the formative stage. Unless the allergic state is eradicated, immunization to colds will continue to be a failure.

A cold should be considered as an allergic response to stimulation by a specific protein, which in this instance is the cold virus. In order to hyposensitize the patient successfully, one must consider factors similar to those noted in hyposensitizing persons to other air-borne allergens. The virus is carried in air droplets over distances of fully 30 to 40 feet (9 to 12 meters)⁵ after a cough or sneeze. One can readily understand that in a crowded room, or in an atmosphere highly impregnated with virus allergen, inhalation by a virus-hypersensitive person can lead to an allergic response or a cold.

⁴ Smillie²; Brennemann, J. Throat Infections in Children, *Arch. Pediat.* 42: 145, 1928.

⁵ Wells, W. F., Stokes, J., Jr., Wells, M. W., and Wilder, T. S. Experiments in the Environmental Control of Epidemic Respiratory Infection, *Tr. & Stud. Coll. Physicians, Philadelphia* 7: 342, 1940.

In a series of 3,000 patients whom we have attempted to immunize to the common cold, over 80 per cent have been proved to be allergic or from an allergic family. Other observers have noted the incidence of colds in allergic persons. Cohen,⁶ in a series of 35 children under 12 years, found that 23 per cent suffered from frequent colds, with sinusitis a major complaint. Sternberg⁷ noted a loss in susceptibility to colds during the winter after a course of specific pollen therapy. He also cited Cooke's statement that 36 of 53 patients who had frequent colds were relieved after pollen therapy. The 17 who were not relieved also did not obtain relief from the hay fever. Fox, Harned and Peluse⁸ reported that in a series of over 1,200 sufferers from frequent colds, 80 per cent were proved to be allergic by the personal and family histories and by skin tests.

The most important accidental factor in infections is trauma. Immunologically speaking, in an allergic response the union of antigen and antibody in the cells results in injury and release from the cell of a preformed histamine-like material. So the stage is set in the nasal mucosa of the allergic patient, through the continuous bombardment by foreign proteins causing injury by the release of H-like materials and the production of a locus minoris resistentiae. It is conceivable, also, that a specific hypersensitivity to the virus protein might exist.

The part played by lowered general resistance, debility or exposure is questionable when one notes a normal incidence of colds in institutions for tuberculous persons or in those having other chronic diseases. On the other hand, inhabitants of Spitzbergen have practically no colds, although most of them, being fishermen, are frequently immersed.⁹ However, when a cargo ship arrives, about 80 per cent of the townsfolk contract colds. It may be said that physically normal persons who exhibit a tendency to frequent colds suffer from an allergic state and, vice versa, that the allergic patient frequently suffers from numerous colds.

PRESENT STUDY

The patients selected for study were those who had had four or more colds a year for a period of at least two years. A careful physical examination was made, with particular emphasis on pathologic condi-

6 Cohen, A. I. Allergy and Its Relationship to Sinusitis and Allied Nasal Conditions, *Arch Otolaryng* **21** 265 (March) 1935.

7 Sternberg, L. The Effect of Pollen Infections on the Common Cold in Hay Fever Subjects, *J Allergy* **6**:304, 1935.

8 Fox, N. Harned, J. W., and Peluse, S. Borderline Allergy Its Relation to Hyperplastic Disease of the Respiratory Tract, *Arch Otolaryng* **31** 502 (March) 1940.

9 Paul, J. H., and Freese, H. L. Epidemiological and Bacteriological Study of the Common Cold in an Isolated Arctic Community (Spitzbergen), *Am J Hyg* **17** 517, 1933.

tions of the ear, nose and throat. A history was obtained as to the presence or absence of any clinically recognizable allergy, past or present, in the patient and his family. His subsequent course was then followed by reexamination, letter and telephone communication.

Method—This investigation had its inception in 1930-1931 in the allergy section of the department of otolaryngology of the University of Illinois College of Medicine.¹⁰ Since 1940 it has been extended to include a parallel study conducted at the Children's Memorial Hospital. Because we had a large group of persons with sinobronchitis and asthma of the intrinsic type who failed to react either to autogenous or to stock vaccines made from nasal washes and sputums, an effort was made to find other materials that might benefit them. With the knowledge that most immune bodies are found in the pseudoglobulin fraction of the blood and that the nasal tissues might be the reservoir for this material, this fraction was obtained from human nasal mucosa harvested during various nasal operative procedures. Since this material was limited in quantity and its use seemed promising in a small number of patients, we looked about for large sources of nasal tissues which might not be too antigenic, but still be easily obtainable. A survey among experts in animal husbandry elicited the information that hogs are probably more resistant to ordinary infections of the upper respiratory tract, other than tuberculosis, than any other common food animal. This opinion was based on the observation that hogs rarely exhibit a purulent nasal discharge. A visit to a local slaughter house corroborated this information. We found pus in only 8 of the sinuses of 500 hog heads examined. On the other hand, almost one third of a like number of sheep showed evidence of sinus infection. Our work, thereafter, centered about the effect of hog pseudoglobulin extract. Three groups, consisting of 90 patients each, were immunized. To the first group a 1:20,000 solution of hog pseudoglobulin was given, to the second group, a 1:20,000 solution of hog euglobulin, and to the third, a 1:20,000 solution of serum albumin, the last two groups being used as controls. The injections were started with 0.1 cc. and increased by 0.1 cc. every fourth day until twenty injections, corresponding to a total amount of 2.0 cc., were given. Briefly, our results revealed that 70 per cent of the patients showed definite improvement with pseudoglobulin therapy, while the degrees of improvement with euglobulin and serum globulin were about the same, namely, 10 per cent.

The unusual observation was made, however, that 30 per cent of the patients receiving pseudoglobulin were free of colds for four months or longer. As a result of this finding, we determined to try to fortify our pseudoglobulin solution, since the reduction of colds definitely produced improvement in those persons whose symptoms were aggravated by colds, particularly by the residual sinus infection remaining after a cold. In order to fortify the pseudoglobulin solution, we added material collected from persons during the first forty-eight hours of an active cold. Our method of collection was to wash out the nose during the first twenty-four to forty-eight hours of a cold with 30 cc. of a 1:20,000 solution of hog pseudoglobulin with the patient placed in the Proetz position. This material was passed through a Seitz filter and frozen in the ordinary refrigerator. Material was collected for three months and pooled. It was then treated with a

¹⁰ Fox, N., and Harned, J. W. Use of Extract of Nasal Mucosa in Treatment of Acute and Chronic Rhinosinusitis. Preliminary Report, Arch Otolaryng 24:89 (July) 1936.

dilute solution of formaldehyde U S P (0.36 per cent) Each patient received five doses, given at four day intervals The first dose was 0.2 cc and was increased by 0.2 cc until 1.0 cc was given Two hundred and fifteen patients were immunized, of whom 66 had an immunity lasting six months or more We reasoned that this high percentage of failures must have been due either to an insufficient quantity injected or to failure to obtain all agents responsible for the cold We then collected materials throughout the year in the same manner as previously described and pooled the entire year's harvest We further increased the number of injections for adults to ten, each injection being increased by 0.2 cc every fourth day until 2.0 cc had been given To children we gave ten doses, with increases of 0.1 cc every fourth day until 1.0 cc had been given

Of the 478 patients who were immunized with this material, 286 obtained an immunity lasting six months Because the formalized material was very painful, we tried killing the virus by heating to 48 C for one hour and using 0.4 per cent phenol or 0.3 per cent cresol for preservative Of the 277 patients immunized with this material, 159 obtained an immunity of six months or longer This result was about the same as that obtained with the formalized material Sixty-five patients were treated with 2 per cent alum-precipitated material, but this vaccine was ineffective A series of 60 patients were treated with virus material combined with the usual catarrhal vaccine, which contained *Streptococcus hemolyticus*, *pneumococcus*, *Klebsiella pneumoniae* (Friedlander's bacillus), *Staphylococcus aureus* and members of the *Streptococcus viridans* group This material was no more effective than the virus material alone For the past six years, all human material has been made up in Coca's buffered saline solution¹¹ With this material we have immunized an additional 640 patients, 390 of whom obtained six months of immunity to colds In all, we have immunized 1,755 patients with material collected directly from persons during the acute stage of a cold

In 1937 we began propagating cold virus in the chorioallantoic fluid of the chick embryo, following the report of Dochez, Mills and Kneeland¹² From that time, our materials have been of two types the type pooled from human colds and used directly after being made up in Coca's solution, and the material harvested from eggs Since we had worked up considerable interest among our cold-susceptible patients, it was an easy matter to collect virus and immediately inoculate prepared eggs Because we had no way of identifying the virus, material was taken from every epidemic outbreak The chick fluid was harvested after twenty-four to forty-eight hours of incubation and pooled at the end of the year Appreciating the danger of possible sensitization to egg albumin, we diluted our material ten times with Coca's solution This material we injected as we had the human material, giving ten doses at four day intervals, starting children with 0.1 cc and increasing the injections by 0.1 cc each time until 1.0 cc had been given Adults were started with 0.2 cc, and the dose was increased by 0.2 cc every fourth day until 2.0 cc had been given

Under existing conditions, one might suppose that the presence of a viable virus might produce colds in many patients Actually, about 60 per cent of the patients had colds during the period of injection However, as this period was over five weeks, it represented a length of time during which the patients would

¹¹ Vaughan, W T Practice of Allergy, St Louis, C V Mosby Company, 1939, p 271 Coca's buffered saline solution contains 0.5 per cent sodium chloride, 0.275 per cent sodium bicarbonate and 0.4 per cent phenol, as a preservative

¹² Dochez, A R, Mills, K C, and Kneeland, Y Studies on the Common Cold, J Exper Med 63 559, 1936

normally have had a cold. We also found that there was a period of from four to six weeks after the injections were finished during which the patient was likely to get a cold.

Up to two years ago, we had immunized 1,120 patients with this material, obtaining an immunization of six months or better in 664 patients. During the past two years, we have prepared our material after the method of Cox and associates,¹³ who concentrated and purified influenza virus by precipitation with alcohol. They demonstrated that methyl alcohol would precipitate influenza virus from infected chorioallantoic fluid and that the optimum concentration of alcohol necessary was 25 to 30 per cent. Briefly, the method is as follows:

Methyl alcohol is added to the allantoic fluid gradually, while the temperature is lowered to 5 C, until a 25 to 30 per cent mixture is obtained. This is allowed to stand for three hours and is then centrifuged at 3,500 revolutions per minute for thirty minutes. In the Cox method, the precipitate is suspended in one-half the original volume of 0.1 molar phosphate buffer solution of p_H 7.0 and is allowed to stand at room temperature for one hour. However, we suspended the material in one-half the original volume of Coca's solution and allowed it to stand at room temperature for one hour. The suspension was then centrifuged at 2,000 revolutions per minute for fifteen minutes at room temperature and placed in the refrigerator for storage until used. With this material we immunized 340 patients, of whom 211 had an immunity to colds for six months.

From time to time, sample harvests were injected or sprayed into the noses of volunteers in order to test for viability of the virus. Over a period of sixteen years we have transferred colds successfully to over 100 volunteers. Some observers have reported characteristic findings produced in volunteers inoculated with cold virus. This has not been our experience. When selecting as volunteers subjects who were susceptible to colds, we noted that the percentage of "takes" ran as high as 75 per cent, some subjects responding with symptoms more or less violent than the donor's. On the other hand, selection of persons not particularly susceptible as volunteers elicited only about 20 per cent of "takes," and frequently these were milder than the donor's cold.

In immunizing a subject to hay fever, a minimum of fifteen injections is usually necessary. Most physicians, when using the perennial method, give about forty injections throughout the year preceding the allergic season. Yet, the hay fever season rarely lasts more than two or three months. On the other hand, the season of colds lasts about ten months, and successful immunization must last over this entire period. Obviously, a small number of injections cannot afford adequate protection for so long a time. We give a total of ten injections, usually increasing each injection by 0.2 cc every fourth day until 2 cc of material is given. However, when unsuccessful, we add another ten doses, beginning again with 0.2 cc, with increases up to the final dose of 2 cc. Ordinarily, we get an immunity of six months from ten doses in about 60 per cent of our patients. An additional ten doses after three months will give a longer immunity. Unfortunately, few patients will submit to so much treatment merely to prevent colds. On the other hand, while a number of patients did experience specific local reactions, none of the 3,000 patients studied suffered an immediate general reaction.

Immunization through the use of nasal tampons soaked in vaccine is being carried out but at present our series is too small to permit proper evaluation of this method.

¹³ Cox, H. R., van der Scheer, J., Aston, S., and Bohnel, E. The Purification and Concentration of Influenza-Virus by Means of Alcohol Precipitation, *J. Immunol.* 56:149, 1947.

It is questionable whether a suspension of cold virus can be used intracutaneously as a test of susceptibility or immunity to colds. It would be desirable to use a test of this sort as an index of susceptibility, as well as a means of determining the dose of material necessary for protection against colds. The effort made toward this end was briefly as follows:

Material for testing was obtained from each epidemic throughout one year in the following manner. At each epidemic, patients with early colds, i. e., of from twenty-four to forty-eight hours' duration, were placed in the Proetz position and their noses perfused with 30 cc of sterile distilled water. Usually six to ten

Results of Treatment of Common Cold by Use of Virus Vaccine

Source	Preservative Killing or Attenuating Agent	Menstruum	Number of Patients Given Injections	Patients Success fully Immun ized for 6 Months	Per cent age	Number of Injec tions per Patient
				No		
Human	Dilute solution of formaldehyde U S P (0.36%)	Nasal washings collected for 3 mo. in hog pseudo globulin solution 1:20,000	215	66	30	5
Human	Dilute solution of formaldehyde U S P (0.36%)	Nasal washings collected for 12 mo. in hog pseudo globulin solution 1:20,000	478	286	59	10
Human	Heated to 48°C for 1 hr., 0.4% phenol or 0.3% cresol	Nasal washings collected for 12 mo. in hog pseudo-globulin solution 1:20,000	277	159	58	10
Human	2% alum precipitated phenol 0.4%	Nasal washings collected for 12 mo. in hog pseudo globulin solution 1:20,000	65	10	15	10
Human	Heated to 48°C for 1 hr., 4% phenol	Nasal washings in pseudo globulin solution and organisms of respiratory tract	60	34	56	10
Human	Phenol	Nasal washings in pseudo globulin solution made up in Coca's solution	640	390	61	10
Chick	Phenol	Nasal washings in pseudo-globulin solution diluted 10 times in Coca's solution	1120	664	59	10
Chick	Phenol	Methyl alcohol precipitated concentrate 2 times in Coca's solution	340	211	62	10

specimens were collected from each epidemic. This material was then passed through a Sertz filter and the filtrate concentrated to one-tenth its volume in a vacuum still. Phenol was added as a preservative. The underlying assumption was, of course, that, although there is a multiplicity of viruses, the material would include the one type of virus responsible for that particular epidemic, the materials from each epidemic were therefore kept separate. Except for the 0.4 per cent of phenol in the solution, no special inactivation of the material was attempted.

The testing was done by injecting intradermally 0.05 cc of the material into the volar surface of the forearm.

While almost all subjects experienced some degree of positive reaction to the cold virus material, many showed a very decided reaction. Some displayed a definite reaction to one material and no reaction to other

materials It is possible that the reaction in each case was determined by exposure to a strain of virus to which the individual subject was specifically susceptible Frequently, a good positive reaction would be seen in a patient who gave a history of having had a cold during the epidemic from which the material was collected

Recent reports by Pollard and Caplovitz¹⁴ and Topping and Atlas¹⁵ on propagation of cold virus in chick embryos and attempts at immunization to colds give further evidence supporting the results of the present study

COMMENT

The limitations of such a study and the many chances of error in interpretation of results have been fully appreciated and, so far as possible, eliminated Primarily, the study has been hampered by the lack of supportive laboratory experimentation

We have had to collect washings empirically from patients during each cold epidemic, so that we do not know how frequently we have duplicated our material In some epidemics this material may have been obtained from 50 persons, and in others the number from whom washings were obtained may have been only 10

By collecting material over a period of a year, we felt that at least a major number of the multiplicity of strains of cold virus would be isolated Obviously, if we have missed some strains, our material will not be completely protective Magill and Francis,¹⁶ in a study of twenty-four strains of influenza virus, showed that there is a striking variation in antigenic characteristics of the different strains They suggested that the structure of the virus of epidemic influenza is a mosaic of antigens and that each strain does not contain all, or even a major part, of the antigenic components of other strains The same reasoning is probably applicable to the various virus strains of the common cold, it also suggests that, in order to be efficacious, a vaccine must include the viruses of all the diseases of the upper respiratory tract

It has not been possible to develop neutralization tests or specific immunologic reactions to cold virus either in human subjects or in animals Cutaneous tests, while frequently giving positive reactions, have failed to produce any dependable factor of correlation Certain clinical pitfalls also have had to be recognized and avoided Our patients were selected because of their susceptibility to colds which we

¹⁴ Pollard, M, and Caplovitz, C D Experimental Studies with the Agent of the Common Cold, *Science* **106** 243, 1947

¹⁵ Topping, N H, and Atlas, L T The Common Cold A Note Regarding Isolation of an Agent, *Science* **106** 636, 1947

¹⁶ Magill, T P, and Francis, T, Jr Antigenic Differences in Strains of Epidemic Influenza Virus Gross Neutralization Tests in Mice, *Brit J Exper Path* **10** 273, 1934

had personally observed either in our clinics or in private practice. However, because some reports of the results of vaccination were frequently made by telephone or postal communication, we had at times to depend on the testimony of the patient. In about 20 per cent of the patients who had apparently benefited by the inoculations the improvement coincided with a successful course of specific allergy hyposensitization. In others, the possibility that a natural immunity to colds had normally developed had to be discounted. This problem was dealt with by giving a course of placebo injections with isotonic sodium chloride solution, after several successful years with cold virus. Those who reverted to their previous susceptibility to colds after the placebo course were then judged to have been helped by the inoculations of cold virus.

The situation was further complicated when attempts were made to estimate the duration of the protection. In most of the successful cases immunity to colds lasted at least one season. Our criterion for a successful immunization was, however, that of a six month period. About 60 per cent of the adults and 65 per cent of the children immunized met this criterion. In many of the unsuccessful cases only one or two colds occurred throughout the six month period, so that, on the basis of the previous two year record of four or more colds per year, this might have been interpreted as an improvement of 50 per cent or better. However, these cases were tabulated as failures. It has been pointed out in this and other studies that the person who has frequent colds has a history of other allergies in himself and in his family. It has also been shown that allergic patients invariably suffer from hyperplastic changes in the upper respiratory tract, particularly the pharynx, nose and sinuses. Obviously, allergic tissues are more easily injured by virus than are normal tissues, so that part of the program in the prophylaxis against colds should include a careful foreign protein survey and immunization to other offending allergens, as well as the use of chemotherapy for prevention of secondary infection.

CONCLUSIONS

Persons who suffer from frequent colds are allergic.

There is considerable evidence to support the contention that the common cold is, at its onset, an attack of acute allergic rhinitis, with the protein of cold virus acting as the exciting agent.

The results of this study also offer evidence that some persons can be successfully hyposensitized with cold virus and remain protected from colds for at least six months.

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USE OF RADIUM IN TREATMENT OF HYPERTROPHIC LYMPHOID TISSUE IN THE NASOPHARYNX

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INCOMPLETE surgical removal is not the only cause of the recurrence of lymphoid tissue in the nasopharynx following adenoidectomy. Even though all visible and palpable areas of adenoid tissue are carefully removed, there may remain seeds of lymphoid tissue in the mucous membrane of the nasopharynx which may increase in size, leading to deafness, chronic pharyngitis, chronic postnasal discharge and otorrhea.

During the past ten years radium has been found to be useful in destroying recurrent lymphoid tissue in the nasopharynx. However, the dose of radiation has not been definitely established.

The aims of this paper are (1) to present a picture of radium therapy as applied to the nasopharynx, including the anatomic, pathologic and physical principles involved, (2) to show the therapeutic indications for the therapy, (3) to outline the therapeutic technic, (4) to compare the results in a short series of cases in which the monel metal® 50 mg radium sulfate applicator was placed eight and one-half minutes to each side of the nasopharynx with the results in a similar series of cases in which the same applicator was placed twelve minutes to each side of the nasopharynx, (5) to demonstrate that the longer, twelve minute, treatment can safely and more effectively destroy recurrent lymphoid tissue.

HISTORY

In 1939 Crowe and Baylor¹ reported beneficial effects of the application of 2 gram-minute doses of radon to each side of the

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From the Otolaryngological Service, Gill Memorial Eye, Ear and Throat Hospital, Roanoke, Va

Read before the class of the Twenty-First Annual Spring Graduate Course in Ophthalmology, Otology, Rhinology and Laryngology of the Gill Memorial Eye, Ear and Throat Hospital, April 7, 1948

Thesis submitted to the faculty of the Graduate School of Medicine of the University of Pennsylvania in partial fulfillment of the requirements for the degree of Master of Medical Science (M Sc [Med]) for graduate work in otolaryngology

¹ Crowe, S J, and Baylor, J W. The Prevention of Deafness, J A M A 112 585 (Feb 18) 1939

nasopharynx to prevent deafness. They pointed out that 40 per cent of children in the 8 to 14 year age group have a hearing impairment for some or all tones above c-4 (2,048 cycles per second). Large adenoid or lymphoid nodules near the nasopharyngeal orifice of the eustachian tube interfere with normal ventilation of the middle ear. In contrast to the generally accepted idea of the effect of chronic catarrhal otitis media in impairing hearing for low tones, adenoids impair hearing for high tones.

In 1943 Fricke and Pastore² reported successful treatment of lateral pharyngeal bands with radium irradiation.

Recently Ward and co-workers³ reported the use of radon in the treatment of asthma in children. Because of the shortage of hospital beds in 1940 and 1941, many children who required adenotonsillectomy were sent to the Radon Clinic of the Johns Hopkins Hospital for irradiation of the nasopharynx. In 1941 Ward observed a decrease in severity and frequency of attacks of asthma in children who were so treated. Follow-up studies confirmed his observation.

During World War II radium was used by the Army Air Forces to prevent and relieve recurrent aero-otitis in flying personnel.⁴

ANATOMY

The recurrent lymphoid masses may occur (1) centrally, in the midline of the pharyngeal vault, producing nasal stuffiness, or (2) laterally, (a) about the torus tubarius and within the eustachian tube, (b) in Rosenmuller's fossa, (c) as lateral pharyngeal bands and (d) as granular pharyngitis.

Hyperplasia of the lymphoid tissue is not always associated with clinical symptoms. The production of symptoms depends on the presence of infection and/or an abnormal size and shape of the nasopharyngeal vault. The lymphoid tissue of the nasopharynx may be the only structure in Waldeyer's ring presenting hyperplastic changes.

Small nodules of lymphoid tissue in Rosenmuller's fossa, about the pharyngeal orifice of the eustachian tube or in the area between the tubal orifice and the posterior end of the middle turbinate body, may seriously impair the ventilating function of the eustachian tubes.⁵ The

2 Fricke, R. E., and Pastore, P. N. Radium Treatment of Granular or Hypertrophied Lateral Pharyngeal Tonsillar Bands, *Radiology* **40** 256 (Sept.) 1943, abstracted, *Proc. Staff Meet., Mayo Clin.* **18** 307 (Aug. 25) 1943.

3 Ward, A. T., Jr., Livingston, S., and Moffat, D. A. Irradiation Treatment of Asthma, *J. A. M. A.* **133** 1060 (April 12) 1947.

4 The Use of Radium in the Aerotitis Control Program of the Army Air Forces, *Ann. Otol., Rhin. & Laryng.* **54** 650 (Dec.) 1945.

5 Harris, H. E., and Montgomery, E. L. The Treatment of Lymphoid Hyperplasia of the Nasopharynx by Radium, *Cleveland Clin. Quart.* **13** 117 (July) 1946.

rich content of lymphoid tissue in the mucous membrane of the nasopharynx and the proximity of the nasopharynx to the nasal passages, paranasal sinuses and eustachian tubes make this area of inflammation the primary focus of infection for many complications about the upper air passages

The lateral pharyngeal bands are linear patches of lymphoid tissue which lie in the most lateral portion of each side of the pharynx, posterior to the pharyngopalatine arch, and usually extend into the salpingopharyngeal fold Fricke and Pastore² divided the lateral pharyngeal bands into three types (1) fine, granular pharyngeal bands, which are evident only when inflamed, (2) coarse, raised, granular pharyngeal bands, which are chiefly inflamed areas with very few crypts, these bands are a common cause of chronic granular pharyngitis, (3) hypertrophic lateral pharyngeal tonsils or tonsillar bands, which are cryptic, thickened bands, resembling the palatine tonsils, but behind the posterior pillars of the fauces

Granular pharyngitis consists of multiple islands of lymphoid tissue in the nasopharyngeal and oropharyngeal walls

Mucous glands are most numerous in the upper part of the pharynx and in the region of the lateral pharyngeal band, where they occur deep beneath the level of the lymph nodules In chronic inflammation the mucous glands become more conspicuous, owing to the increased number of alveoli Conspicuous lateral pharyngeal bands are due to hyperplasia of the glandular elements rather than to hyperplasia of the lymphoid tissue⁶ This may account for apparent failures of treatment of lateral pharyngeal bands

PATHOLOGY

Infections of the upper respiratory tract result in hyperplasia and hypertrophy of the lymphoid tissue in the nasopharynx Even if the acute symptoms subside without systemic complications, the mechanical obstruction to breathing and to the eustachian tubes, the hypersecretion of mucus and the lowered resistance of the patient predispose to recurrence of the infection or progression to a chronic condition When the tonsils and adenoids are removed, it is impossible to remove all the lymphoid tissue in the mucous membrane of the nasopharynx In some children infections continue to recur after adenotonsillectomy, and the posterior and lateral walls of the pharynx become studded with nodules of lymphoid tissue, known as granular pharyngitis The orifice of the eustachian tube may be occluded by an overgrowth of the lymphoid tissue in Rosenmuller's fossa, around the *tortus tubarius* or within the

⁶ Schenck, H P Histopathological Changes Occurring in Chronic Infection of the Pharynx, *Ann Otol, Rhin & Laryng* 50 817 (Sept) 1941

tube itself. The overgrowth may also extend upward on the anterior surface of the sphenoid bone as high as the level of the middle turbinate body.⁷

When the atmosphere is frequently filled with a heavy concentration of smoke or dust, postnasal discharge is a common complaint. This is the result of the physiologic effect of an oversecretion of mucus and the action of the cilia in moving the mucous blanket to the nasopharynx. Examination by means of the electric nasopharyngoscope reveals a mass of hyperemic lymphoid tissue in the nasopharynx, covered with a thick, tenacious discharge. There is also hypertrophy of the mucous membrane overlying the posterior end of each inferior turbinate body.⁸

Most microscopic studies of the eustachian tube and its opening into the nasopharynx had been done on infants or embryos prior to the time that Fowler⁹ examined 103 pairs of temporal bones of military personnel killed in the European Theater of Operations during World War II. About one third of his specimens showed tissue protruding from the torus tubarius along both the salpingopharyngeal and the salpingopalatine folds. About one-half showed an abundance of lymphoid tissue on the posterior pharyngeal wall. Microscopically he noted typical lymphoid tissue about the salpingopharyngeal fold. The men who had had radium therapy showed absence of germinal centers and prominence of the endothelium of capillaries. About two thirds of the specimens examined microscopically showed eustachian salpingitis. Lymphoid masses were rare except near the pharyngeal orifice of the tube, but were found anywhere along the tube, and even in the middle ear.

Histologic study of tissue removed from the nasopharynx eighteen to twenty-four hours after a single irradiation showed changes only in the germinal centers of the lymphoid tissue. The mature lymphocytes, the epithelium, the vascular endothelium and all other tissues appeared normal. In the germinal centers, cellular debris and large phagocytes containing fragmented cells were observed. No mitotic figures were seen. Biopsy one week after irradiation showed recovery, mitotic figures were seen again and much of the cellular debris had been removed. These observations indicate that the dose used destroyed only the cells undergoing mitosis at the time of the treatment. This destruction interrupted the normal cycle of replacement of mature lymphocytes. The size of the lymph nodule depends largely on the

7 Crowe, S. J. The Nasopharynx, *Arch Otolaryng* **33** 618 (April) 1941

8 Fisher, G. E. Recognition and Radium Treatment of Infected and Hypertrophied Lymphoid Tissue in the Nasopharynx, *Arch Otolaryng* **37** 434 (March) 1943

9 Fowler, E. P., Jr. Irradiation of the Eustachian Tube, *Arch Otolaryng* **43** 1 (Jan) 1946

number of mature lymphocytes These mature lymphocytes are constantly being used up, discarded and replaced by mitosis of the germinal center cells Properly spaced radium treatments prevent the replacement of lymphocytes and thus cause a gradual and progressive reduction in the size of the lymphoid tissue⁴

PHYSICAL FACTORS

Three types of rays are emitted by radium preparations alpha, beta and gamma A large part of the energy emitted is in the form of alpha rays These rays have so slight a penetrating power that they are completely absorbed by the monel metal® capsule of the applicator and therefore have no therapeutic value Beta rays have considerable power of penetrating matter About 75 per cent of such rays are absorbed in the first 3 mm of tissue, but 6 or 7 per cent of the beta rays are still present after passing through 20 mm of a tissue¹⁰ Beta rays are valuable in treating superficial conditions amenable to radiation therapy Gamma rays are more likely to cause internal injuries However, less than 10 per cent of the gamma rays are absorbed The effects aimed for in and obtained by radiation therapy are entirely dependent on absorption of radiation by the tissues Rays that pass through the body and are not absorbed have no therapeutic value¹¹ With the 0.3 mm monel metal® filtration used in the Army type 50 mg radium sulfate nasopharyngeal applicator, the rays emitted consist of approximately 30 per cent beta rays and 70 per cent gamma rays⁴

THERAPEUTIC INDICATIONS

The first use of radium in the treatment of hypertrophic lymphoid tissue in the nasopharynx was for the prevention or cure of impaired hearing, especially in children Later, radium irradiation was extended to treatment of recurrent colds with aural or sinus complications, recurrent adenoids, aerotitis, granular or hypertrophic lateral pharyngeal bands, chronic otorrhea and, in selected cases, asthmatic bronchitis

The first evidence of impaired hearing due to obstruction of the eustachian tubes is loss of hearing for high tones and may escape detection with the usual hearing tests, but as the condition progresses the lower tones are lost, until the conversational range is affected and deafness becomes evident

Nerve deafness or otosclerosis may be superimposed on conduction deafness due to occlusion of the eustachian tubes Irradiation is indicated

¹⁰ Burman, C. F., and Crowe, S. J. The Monel Metal Radium Applicator Designed for Maximum Use of Hard Beta Rays in the Treatment of Nasopharyngeal Lymphoid Tissue, *Mississippi Valley M. J.* 67 109 (Oct.) 1945

¹¹ Burman, C. F. General Factors in Irradiation Therapy, *Ann. Otol., Rhin. & Laryng.* 55 764 (Dec.) 1946

in such cases if lymphoid tissue is found in the nasopharynx. The radium therapy may restore hearing to a more useful level, although nothing is gained so far as the underlying primary condition is concerned¹²

Crowe¹³ pointed out that recurrence of adenoids after operative removal is so frequent that it must be regarded as normal. The recurrence of the adenoids is not always due to incomplete operation, but is to be explained chiefly by the fact that lymphoid tissue is an integral part of the mucous membrane of the posterior and lateral walls of the pharynx and that in some children it hypertrophies as a result of infection, allergy and other causes, not understood.

Adenoids should not be removed in patients with cleft palate. Many children, after a successful operation for cleft palate, acquire a normal

TABLE 1—*Distribution of Patients According to Therapeutic Indications**

	Per centage of All Patients (74)	Duration of Treatment			
		8½ Min (41 Patients)		12 Min (33 Patients)	
		No	%	No	%
Age					
Children	34	16	39	9	27
Adults	66	25	61	24	73
Recurrent central adenoids	36	22	54	5	15
Progressive deafness	26	7	17	12	36
Tubal tonsil	23	2	5	15	45
Chronic otorrhea	18	8	19	5	15
Lateral pharyngeal bands	15	7	17	4	12
Granular pharyngitis	20	5	12	10	30
Postnasal discharge	12	4	10	5	15
Postadenotonsillectomy	5	2	5	2	6
Recurrent suppurative otitis media	3	2	5		
Patients who discontinued treatments		6		1	
Patients whose treatments are incomplete at time of writing				9	

* Some patients manifested more than one therapeutic indication

tone of voice, but later fall into the hands of some one unaccustomed to the particular situation, who may advise that the tonsils and adenoids be removed. If the patient follows this advice, he will resort subsequently to the tone of voice associated with cleft palate. Instead, if the adenoid tissue is treated by radium in fractionated doses, the deafness, the frequent colds and their complications which often develop in children with cleft palate can be remedied.

In certain cases in which the tonsils seem definitely pathologic, they alone may be removed, but the adenoids should be left in place to preserve normal speech resonance. The adenoid masses help greatly in

12 Crowe, S. J., and Walzl, E. M. Irradiation of Hyperplastic Lymphoid Tissue in the Nasopharynx, *J. A. M. A.* **134** 124 (May 10) 1947

13 Crowe, S. J. Irradiation of the Nasopharynx, *Ann. Otol., Rhin. & Laryng.* **55** 779 (Dec.) 1946

closing off the nasopharynx after operation for cleft palate because in nearly all such cases the palate, after repair, retracts forward in the line of central scar and pulls it away from the posterior pharyngeal wall, making it almost impossible for the patient to close off the nasopharynx in the normal manner. Complete surgical removal of the adenoids only adds to this difficulty¹⁴

Patients with chronic otorrhea who should be chosen for treatment with radium are those whose persistent discharge appears to be due to hypertrophied lymphoid tissue in and about the eustachian orifice. All lesions of the upper respiratory tract, such as deviated nasal septum, sinus disease and hypertrophied tonsils and adenoids, which might contribute to the otorrhea must be corrected. Aural polyps, granulations, caries of the ossicles and signs of mastoiditis must have the more radical surgical treatment¹⁵ of polypectomy and mastoidectomy.

The child with frequent winter colds associated with asthmatic bronchitis derives dramatic relief from radium treatment of lymphoid tissue in the nasopharynx. It is best to give the treatments during the summer season, for infections of the respiratory tract are not then so prevalent and the treatment is less likely to be interrupted. Similarly, a persistent winter cough due to postnasal discharge in a child or an adult may be relieved when the lymphoid tissue of the nasopharynx is irradiated¹⁶

EXAMINATION OF THE PATIENT

After the nasal mucosa has been thoroughly shrunk and moderately anesthetized, the nasal passages are inspected with reflected light. The examiner should identify and investigate the various deep structures by palpating gently with a tightly wound applicator and by fixing his gaze on the posterior wall of the nasopharynx at the level of the floor of the nose and requesting the patient to swallow. This act will bring the posterior surface of the soft palate into view if large adenoids or other growths do not retard the elevation of the palate.

When the throat is examined, granular pharyngitis and the lower portion of lateral pharyngeal bands may be observed. The postnasal mirror examination gives a satisfactory view of the nasopharynx if the patient is cooperative and can breathe through his nose when his mouth is open, thus suspending the soft palate far forward.

After mucopus has been aspirated from the floor of the nose, the electric pharyngoscope is passed along the floor of the nose to the naso-

14 Straith, C. L. Personal communication to the author.

15 Emerson, E. B., Jr., and Dowdy, A. H. Radium Therapy as an Aid in the Control of Chronic Otorrhea, *Am J Roentgenol* 49 234 (Feb) 1943.

16 Gray, L. N. The Treatment of Residual Lymphoid Tissue in the Nasopharynx by Radium, *J Allergy* 17 348 (Nov) 1946.

pharynx If the patient keeps his mouth closed and breathes through his nose, the soft palate is relaxed and a rapid, thorough inspection of the nasopharynx can be made By passing the pharyngoscope through a hole in a gauze square or paper towel the examiner affords some protection for himself¹⁷

The ears should be carefully examined for increased prominence of the short process and handle of the malleus, with foreshortening of the handle, prominent folds to each side of the short process and a diffuse light reflex Sharpnell's membrane is often greatly retracted There may be opacity and dulness of the drum membranes Hearing tests should include the Weber, Schwabach and Rinne tests with tuning forks, and an audiogram should be made before the beginning of the radium treatments and, again, eight weeks after the last treatment

TABLE 2—*Distribution of Patients According to Results of Radium Therapy*

	Duration of Treatment			
	8½ Min		12 Min	
	No	%	No	%
Recurrent central adenoids disappeared	20	91	5	100
Hearing improved to practical level	4	57	12	100
Hearing improved, but not to practical level	2	28		
Tubal tonsil disappeared	2	100	15	100
Chronic otorrhea relieved	5	62	1	20
Lateral pharyngeal bands disappeared	1	14	1	25
Flat, smooth lateral bands in oropharynx	6	86	3	75
Granular pharyngitis disappeared	3	60	5	50
Granular pharyngitis persisted in oropharynx	2	40	5	50
Postnasal discharge relieved	3	75	4	80
No adenoid tissue observed after adenotonsillectomy	2	100	2	100
No recurrence of suppurative otitis media	2	100		
No change in symptoms, but lymphoid tissue disappeared				
Otorrhea continued	3		4	
Postnasal discharge continued	1		1	
Hearing unchanged	1			
Reactions	1		2	
Surgical adenoidectomy advised	2			

Large masses of adenoid tissue may be palpated, with the finger of the examiner sweeping about the nasopharynx through the mouth while simultaneous pressure is exerted through the cheek to prevent the patient from biting down on the examiner's finger A single lateral roentgenogram of the pharyngeal area will show the size and encroachment on the breathing space of an adenoid mass¹⁸

Examination of a child 6 months to 6 years of age is difficult However, all children who have not had an adenoidectomy have lymphoid tissue in the nasopharynx When this is removed surgically, the naso-

17 Kline, O R Importance of Pathologic Conditions in the Nasopharynx to the Otolaryngologist, *Arch Otolaryng* 41 140 (Feb) 1945

18 Pancoast, H K, Pendergrass, E P, and Schaeffer, J P The Head and Neck in Roentgen Diagnosis, Springfield, Ill, Charles C Thomas, Publisher, 1940, p 851

pharynx can be adequately inspected by passing urethral rubber catheters through the nose to elevate the soft palate. A Yankauer pharyngeal speculum or a Love palate retractor may be used. If the history indicates obstruction to the eustachian tubes, recurrent colds with postnasal discharge or asthmatic bronchitis, the adenoidectomy should be followed by three radium treatments at two week intervals, the course beginning two weeks after the operation. Other children may be immobilized by wrapping them in a sheet in the recumbent position, lightly anesthetizing the nasal passages with tetracaine hydrochloride applied topically and passing the nasopharyngoscope.

I do not feel that the first radium treatment should be given on the operating table at the time of adenoidectomy because of (1) the technical difficulties of administering the treatment with the patient under general anesthesia without unduly exposing the anesthetist to the radium radiation, and (2) the edematous reaction produced by the irradiation therapy, which would aggravate the postoperation reaction.

TECHNIC OF THERAPY

- 1 The nasal mucous membrane is anesthetized with 2 per cent tetracaine hydrochloride solution.

- 2 After the radium applicator is removed from the lead cylinder, the applicator is washed in running water.

- 3 With the patient recumbent, the applicator is passed along the floor of the nasal passageway to the posterior pharyngeal wall. The head of the patient is turned so that the weight of the handle of the applicator causes the opposite end to come into close proximity with the orifice of the eustachian tube. The application of the radium is timed for exactly twelve minutes by means of the alarm clock timer used in the dark room technic of roentgenography.

- 4 The applicator is then moved to the other side of the nose and the head of the patient rotated to the other side, so that the radium tip of the applicator comes in close proximity with the eustachian orifice. This application is likewise timed for twelve minutes.

- 5 After each insertion of the applicator, the operator goes to another room. The mother of the child may stay with the patient. Distance is the best protection from the accumulative effect of the radiation. Lead apron and gloves give the operator some protection. Three millimeters of rubber absorb about 75 per cent of the beta rays. The gamma rays penetrate the rubber.

- 6 Mucus adhering to the applicator is removed with a brush on a long handle or by laying a hand scrubbing brush on the sink and working the applicator through the bristles, holding the applicator by the milled handle on the end distant to the radium capsule. The operator must not hold the brush on the sink with his hand when he is working the applicator through the brush. He must never clean the radium capsule with an alcohol-saturated sponge held by his fingers, even though he is wearing lead rubber gloves.

- 7 The applicator is quickly returned to its lead cylinder, where it is stored at least twenty feet (6 meters) from where personnel are working.

- 8 The application is repeated every two weeks for three treatments. At each visit the patient is reexamined for evidences of nasopharyngitis and the

effect of the previous treatment. Two months after the last treatment audiograms are taken to determine the effect of the therapy. Only in exceptional circumstances, and on the advice of a radiologist, is a second course of treatment given within six months after completion of the first course.

9 If acute nasopharyngitis is present, no radiation is given. If mild or chronic nasopharyngitis is present, the radiation is given six minutes to each side and the treatment repeated in seven days. After three weeks, if the nasopharyngitis persists, the same treatment (six minutes' irradiation to each side) is given and repeated in seven days. Three weeks later a final treatment of twelve minutes' irradiation to each side is given.

PERSONAL OBSERVATIONS

During the year Feb 1, 1947 to Feb 1, 1948, 74 patients were given radium treatments at the Gill Memorial Eye, Ear and Throat Hospital, they were divided into two treatment groups, as follows:

Forty-one patients were treated by placing the monel metal® applicator containing 50 mg. radium sulfate eight and one-half minutes to each side of the nasopharynx. Of these 41 patients, 35 were given three treatments at two week intervals, 6 patients had but one treatment and did not complete their series. A total of 111 treatments were given to patients in this eight and one-half minute group.

Thirty-three patients were treated by placing the same applicator to each side of the nasopharynx for twelve minutes. Of these 33 patients, 23 were given three treatments at two week intervals, 9 patients began their series but still have treatments to undergo, and 1 patient interrupted his series. A total of eighty-eight treatments were given in this twelve minute group.

Since radiation therapy produces results only over relatively long periods, it is difficult to evaluate the results of a one year study. The results recorded in this study are based on (1) the subjective improvement of symptoms, (2) the objective observance of the disappearance of the lymphoid tissue which had been noticed before the radium was administered and (3) the results of audiometric hearing tests in cases of defective hearing.

Nineteen patients were treated for defective hearing associated with lymphoid tissue in the nasopharynx. Seven of these patients had three irradiations of eight and one-half minutes to each side of the nasopharynx, resulting in improvement of hearing to a practical level in 4 patients (57 per cent), improvement, but not to a practical level, in 2 patients (28 per cent) and no change in 1 patient. Twelve patients had three irradiations of twelve minutes each to each side of the nasopharynx, and all (100 per cent) had their hearing restored to a practical level.

Thirteen patients had chronic otorrhea with lymphoid tissue in the nasopharynx. 8 patients had the shorter irradiation (eight and one-half minutes), in 5, or 62 per cent, of whom dry ears were observed eight

weeks after the last irradiation, 5 patients had the longer irradiation (twelve minutes to each side), only 1, or 20 per cent, of whom had dry ears eight weeks after irradiation

Twenty-seven patients were treated for recurrent central adenoids. Of the 22 patients having the shorter irradiation (eight and one-half minutes to each side), 20, or 91 per cent, had no adenoid tissue eight weeks after irradiation, and 2, or 9 per cent, had to have a surgical adenoidectomy because the mass was large on follow-up examination, 5 patients had the longer irradiation (twelve minutes to each side), and all (100 per cent) showed absence of the adenoid tissue on the follow-up examination

Eleven patients were treated for lateral pharyngeal bands. Two types of results were observed: (1) disappearance of the bands, in a very few patients, and (2) persistence of smooth, flat lateral bands in the oropharynx below the soft palate. The granular and cryptic appearance of the bands was not observed at the follow-up treatment. However, a few patients with residual flat, smooth oropharyngeal bands did suffer from sore throat. Of the 7 patients who were given the shorter therapy (eight and one-half minutes to each side), 6 or eighty-five per cent, had the smooth, flat oropharyngeal bands at the eight week post-irradiation examination, and only 1, or 14 per cent, showed no lateral band. Of the 4 patients who were given the longer therapy (twelve minutes to each side) 3, or 75 per cent, had the residual, smooth oropharyngeal bands, and 1, or 25 per cent, had no lateral band.

Fifteen patients were treated for granular pharyngitis. Of the 5 patients given the shorter radiation treatment (eight and one-half minutes to each side) 3, or 60 per cent, showed no granular pharyngitis, and 2, or 40 per cent, had oropharyngeal granular pharyngitis similar to the condition of the lateral bands. Of the 10 patients given the longer treatment (twelve minutes to each side), 5, or 50 per cent, had no granular pharyngitis, and 5, or 50 per cent, showed the residual granular oropharyngitis.

Seventeen patients had adenoid tissue in or about the orifice of the eustachian tube. All these patients (100 per cent) showed no lymphoid tissue when examined eight weeks after the last treatment.

Nine patients had a postnasal discharge associated with lymphoid tissue in the nasopharynx. Four patients were given the shorter treatment (eight and one-half minutes to each side), of these, 3, or 75 per cent, reported that they had had complete relief, in the other patient the lymphoid tissue disappeared, but the discharge persisted at the follow-up examination. Five patients had the longer irradiation (twelve minutes to each side), of these, 4 (80 per cent) reported complete relief of symptoms, and the other patient did not complete his series of treatments.

Two patients had the shorter irradiation (eight and one-half minutes to each side), and 2 patients had the longer irradiation (twelve minutes to each side) after adenoidectomy and tonsillectomy because excessive adenoid tissue was observed at the time of operation or because the history revealed recurrent colds or recurrent otitis media. At the time of this report, no recurrent adenoid tissue has been observed in any of these patients.

In only 1 patient, or 2 per cent, did a reaction appear to the shorter irradiation (eight and one-half minutes to each side), and 2 patients, or 6 per cent, showed reactions to the longer treatment (twelve minutes to each side). These reactions consisted of nasal stuffiness, aural stuffiness and sore throat.

SUMMARY

The rays emitted by the Army type 50 mg radium sulfate nasopharyngeal applicator are used to destroy hypertrophic lymphoid tissue in the nasopharynx. The selective action of the beta rays on lymphoid tissue stops cellular mitosis at the time of treatment.

In selected cases, removal of the hypertrophic lymphoid tissue prevents or cures impaired hearing, recurrent nasopharyngitis, aural stuffiness and otorrhea.

A comparison of a short series of patients treated by placing the applicator eight and one-half minutes to each side of the nasopharynx with a similar series of patients treated by placing the applicator twelve minutes to each side of the nasopharynx shows that the longer treatment removes lymphoid tissue safely and more effectively.

130 Seventh Street

ABSCCESS OF THE CEREBELLAR LOBE OF OTOGENIC ORIGIN

Combined Otolaryngologic and Neurosurgical Treatment in Six Cases

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CEREBELLAR abscess is apparently a rare complication of otitis media. Only 6 patients with this lesion have been encountered at the Mayo Clinic during the last ten years. Meltzer¹ reported only 2 encountered during an eleven year period at the Massachusetts Eye and Ear Infirmary. Courville and Nielsen² found only 12 cerebellar abscesses in a review of the results of 10,000 necropsies covering a fifteen year period. Despite its infrequent occurrence, this condition occasionally presents itself and knowledge of its various aspects is important.

The routes by which infection may spread from the middle ear and the cells of the mastoid process are conducive to the formation of supratentorial or infratentorial abscesses of the brain. As pointed out by Brunner,³ Atkinson⁴ and others, there are four possible pathways: 1 The lateral sinus may become thrombosed as a result of being in direct contact with infected cells of the mastoid process. Perisinus abscess or localized meningitis may follow, from which in turn infection may extend either directly to the brain along a thrombosed vein by way of a perivascular space or by penetration of the dura in an area of pressure necrosis. 2 The numerous connections of the veins,

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1 Meltzer, P E. Treatment of Thrombosis of the Lateral Sinus. A Summary of the Results Obtained During Twelve Years at the Massachusetts Eye and Ear Infirmary, *Arch Otolaryng* **22** 131-142 (Aug) 1935

2 Courville, C B, and Nielsen, J M. Intracranial Complications of Otitis Media and Mastoiditis. Statistical Study with Survey of Ten Thousand Necropsies, *Acta oto-laryng* **21** 19-60, 1934

3 Brunner, H. Intracranial Complications of Ear, Nose and Throat Infections, Chicago, The Year Book Publishers, Inc, 1946

4 Atkinson, M. Otogenous Cerebellar Abscess, *Ann Otol, Rhin & Laryng* **47** 1020-1034 (Dec) 1938

laterally placed in the posterior fossa, enable the infection to reach adjacent portions of the brain both from the lateral sinus and directly from the cells of the mastoid process or the petrous portion of the temporal bone 3 A frequent course is that by way of Trautmann's triangle From the labyrinth the infection may reach the cerebellum by local destruction of bone or by passing along the aqueduct of the cochlea or the endolymphatic duct 4 Infection has been known to follow the course of the fallopian canal, but this is most unusual

Chronic suppurative otitis media is generally considered the principal etiologic agent in the formation of cerebellar abscess Kopetzky ⁵ stated that in 85 per cent of cases otogenic cerebellar abscess is due to chronic infection of the ear Asherson ⁶ in a review of English literature stated that in 33 of 41 cases of abscess of the cerebellar lobe the lesion was secondary to chronic otorrhea and that in 8 it was secondary to acute otorrhea In 4 of the 6 cases reported in this paper abscess of the cerebellar lobe followed chronic infection of the middle ear On the other hand, Brunner,³ Wilkins,⁷ Schreiber ⁸ and others have reported cerebellar abscess arising secondary to acute otitis media in a much higher percentage of cases than we have

Although numerous controversial aspects exist in regard to the management of cerebellar abscess, these will not be discussed here It is generally agreed that since the vast majority of cerebellar abscesses are otogenic, the primary focus of infection must be removed Close cooperation of the otologist and the neurosurgeon is desirable whenever this association is feasible Factors involved in given cases will determine the nature of the surgical intervention if such intervention is indicated In Wilkins' series,⁷ mastoidectomy was performed before, at the time of, and in some cases after, drainage of the cerebellar abscess In our series it was performed both during and after drainage of the abscess The optimal time of operation is when encapsulation has occurred The route of approach should be through the mastoid portion of the temporal bone when the adjacent portion of the dura is eroded However, a surgical approach through a clean field is indicated if a definite preformed pathway is not encountered Successful results

5 Kopetzky, S J Surgery of the Ear, New York, Thos Nelson & Sons, 1947, pp 84-89

6 Asherson, N The Otogenic Cerebellar Abscess, with Special Reference to the Posterior Fossa Cerebrospinal Fluid Syndrome, *J Laryng & Otol* **57** 129-156 (March) 1942

7 Wilkins, H Cerebellar Abscess Review of Cases, *South M J* **33** 605-610 (June) 1940

8 Schreiber, F Cerebellar Abscesses of Otitic Origin in Nine Children Eight Recoveries After Cannulation, *Ann Surg* **114** 330-335 (Sept) 1941

have been obtained by either approach, however, as indicated by the reports of Atkinson,⁴ Wilkins,⁷ Schreiber,⁸ Howie,⁹ Lewy¹⁰ and others

Recently, radical treatment of cerebral abscess has received more emphasis than the conservative type previously used, as reported by MacCarty and Griffin¹¹ and others¹² It consists of craniotomy, extirpation of ragged, friable walls of the abscess and of necrotic brain tissue, and primary closure without drainage Adequate amounts of sulfadiazine and penicillin must be administered before and after operation The last patient in our series successfully underwent radical removal of a cerebral abscess performed by one of us (A U)

The prognosis of cerebellar abscess secondary to otitis media under treatment should be more favorable than some of the literature would indicate Without surgical treatment the condition is 100 per cent fatal Even with such treatment, some clinics have reported a mortality rate of almost 100 per cent Brunner reported a mortality rate of 85 per cent in his group of 13 cases Yaskin¹³ had fatalities in 3 of 4 cases Shuster¹⁴ reported 5 recoveries in 11 cases of abscess of the cerebellar lobe Asherson reviewed the postoperative results in 70 cases of abscess of a cerebellar lobe over a twenty year period (1920 to 1940) He found that 41 patients (59 per cent) had recovered and 29 (41 per cent) had died Schreiber reported recovery of children in 8 of his 9 cases Both of Meltzer's patients recovered Low mortality rates have also been reported by Wilkins, Atkinson and others In 4 of 6 cases reported in the present article the patient recovered The 2 patients who died were critically ill at the time of

9 Howie, T O A Case of Cerebellar Abscess Treated by Drainage and Penicillin Instillation, *J Laryng & Otol* **59** 226-230 (June) 1944

10 Lewy, R B Scarlet Fever, Bilateral Mastoiditis with Intervening Pneumonia and Cerebellar Abscess with Recovery, *Ann Otol, Rhin & Laryng* **51** 264-267 (March) 1942

11 MacCarty, C S, and Griffin, J G Some Modern Concepts in the Treatment of Brain Abscess Report of Three Cases, *Proc Staff Meet, Mayo Clin* **23** 57-63 (Feb) 1948

12 Gurdjian, E S, and Webster, J E Observations on Standardizing the Surgical Management of Intracranial Suppuration, *J Neurosurg* **5** 1-10 (Jan) 1948 Fincher, E F Craniotomy and Total Dissection as a Method in the Treatment of Abscess of the Brain, *Am J Surg* **123** 789-805 (May) 1946 Webster, J E, Schneider, R C, and Lofstrom, J E Observations on Early Type of Brain Abscess Following Penetrating Wounds of the Brain, *J Neurosurg* **3** 7-14 (Jan) 1946 LeBeau, J Radical Surgery and Penicillin in Brain Abscess A Method of Treatment in One Stage with Special Reference to the Cure of Three Thoracogenic Cases, *ibid* **3** 359-374 (Sept) 1946

13 Yaskin, J C Neurologic Complications of Infections of Temporal Bone and Paranasal Sinuses Summary of Twenty Years' (1919 to 1938) Experience, *Arch Otolaryng* **30** 157-182 (Aug), 360-388 (Sept) 1939

14 Shuster, B H Cerebellar Abscess, *Arch Otolaryng* **34** 952-957 (Nov) 1941

their admission and failed to rally after emergency surgical intervention. It is reasonable to assume that prognosis will be good if early diagnosis and accurate localization are combined with prompt, adequate surgical intervention supported by administration of penicillin and sulfonamide drugs.

The sulfonamide drugs and penicillin provide effective measures for the treatment of acute suppurative otitis media and for the prevention of its complications. Experience has shown that when these therapeutic agents are used judiciously the number of cases in which mastoidectomy is performed for acute involvement diminishes greatly. With the widespread use of these agents, the cerebellar abscess will probably not be seen as a complication of acute otitis media as frequently as heretofore. By the same reasoning, chronic otorrhea will develop in fewer patients who have acute otitis media.

The chronically infected ear requires good conservative treatment or operative care. Between 1929 and 1939 Asherson treated 4,000 patients who had chronic otorrhea. In this series of consecutive cases, there was not a single instance in which intracranial complication was observed. Of the 4,000 patients, 400 required mastoidectomy.

Reports follow concerning 6 patients seen at the Mayo Clinic over a ten year period.

REPORT OF CASES

CASE 1—A white boy, 15 years of age, was admitted to the clinic and hospitalized on May 19, 1946. Two weeks prior to his admission he had complained of stiffness and soreness of the back of the neck. Twelve days prior to admission he had had two episodes of emesis and generalized headache. Seven days before admission ataxia was evident, with clumsiness of the left hand. According to his history, chronic bilateral otitis media with intermittent periods of drainage had been present since the age of 2 years. For one to two years prior to his admission there had been yellowish purulent drainage almost daily from one or both ears. Otherwise his general condition was essentially normal.

At the time of the patient's admission there was a watery, greenish, slightly odorous fluid being discharged from the left ear. A large perforation was located posteriorly in the left ear drum, from which the discharge came. A moderate degree of conduction deafness was noted. A small amount of fluid was being discharged from an attic perforation in the right ear. Neurologic examination revealed definite ataxia on the left and definite incoordination of movement of the left upper and lower extremities. There was some weakness of the fingers of the left hand on flexion and mobility. Romberg's sign was positive to the left.

The patient had horizontal nystagmus in the right eye, grade 1, and in the left eye, grade 2 to 3 (grading was on the basis of 1 to 4, 1 being the least and 4 the greatest degree). There was also vertical nystagmus. The results of a fundusoscopic examination were essentially negative, edema was not visible, but there was thickening at the poles. The visual fields were essentially normal. Roentgenograms of the mastoid processes revealed evidence of a destructive lesion on the right and destruction of the mastoid portion of the temporal bone on the left,

which involved the antrum tympanicum and the posterior superior portion of the temporal bone. The roentgenologist felt that there was an extensive area of cellular destruction with apparent involvement of the tegmen mastoides-tympanicum. It was the impression of one of us (O E H) that the lesion could easily be associated with an epidural abscess.

Urinalysis revealed albuminuria, grade 2, and a few erythrocytes and pus cells, the leukocyte count was 11,600 per cubic millimeter of blood.

A neurosurgical consultation was held on May 24. The patient received penicillin and supportive treatment before operation. Sulfadiazine was given preoperatively, 75 grains (5 Gm) a day, from May 24 to May 27. There was some discussion as to whether operative treatment of the mastoid process should precede an exploration for cerebellar abscess, but, because of the ataxia and the headache, it was decided to explore first.

On May 28 suboccipital craniotomy was carried out on the left side. An abscess 3 cm in diameter or larger was encountered in the left cerebellar lobe, and about 1 ounce (29.5 cc) of thick, greenish yellow pus was removed. The wound was irrigated with a saline solution and penicillin, and the abscess was drained by means of a rubber tube. Fifty thousand Oxford units of penicillin was injected.

The patient's convalescence was uneventful. He received a total of 200,000 Oxford units of penicillin intramuscularly daily from May 24 to June 3. On the ninth postoperative day, June 5, radical mastoidectomy was performed on the left for suppurative chronic otitis media with mastoiditis and cholesteatoma. On resection of the mastoid cavity, the dura was exposed on either side of the superior petrosal sinus, and evidence that the infection had directly penetrated through the dura on this level made clear the source of the abscess of the brain. The patient responded well to the operation. Penicillin was administered intramuscularly for five days postoperatively.

On July 17, radical mastoidectomy was carried out on the right side by the anterior auricular approach. The cavity of the middle ear was completely filled with cholesteatoma, and there was beginning caries of the ossicles. Convalescence was uneventful after the second mastoidectomy. The drainage, which was considerable, gradually cleared. The drainage tube was removed from the site of the cerebellar abscess on the left side on the fifteenth postoperative day. The wound healed without further complication or drainage.

A postoperative neurologic examination did not reveal headache, dizziness or ataxia. A slight degree of diplopia persisted, but coordination had improved markedly. The patient was dismissed on October 26. On reexamination, Feb 8, 1947, he was found to be making satisfactory progress. He returned for reexamination at intervals and was last seen March 1, 1948. At that time residual manifestations of his neurologic deficit were not noted, and both mastoid cavities were clean and dry.

CASE 2—A white boy, 17 years of age, was admitted to the clinic on April 29, 1938. One month prior to his admission he had influenza complicated with pneumonia. His symptoms included earache, fever, cough, delirium, diarrhea, emesis and urinary incontinence. He recovered rapidly and was feeling well until two weeks before he was admitted to the hospital, when he complained of earache on the left side. The ear drained spontaneously, and the accompanying symptoms were malaise and excessive fatigability. These symptoms persisted until April 28, when he had an attack of projectile vomiting, and severe occipital headaches and dizziness were noted. Within a few hours, he became stuporous and was hospitalized. His condition continued downward.

On his admission the patient's temperature was 98.8 F, his pulse rate was 72 beats per minute and his respiratory rate 22 per minute

He responded with difficulty during physical examination and was unable to stand. Nuchal rigidity was not evident. Purulent exudate was present in the left auditory canal, and slight edema of the left optic disk was noted.

A spinal tap was done, and the fluid which was obtained was slightly opaque. It contained 145 lymphocytes and 95 polymorphonuclear cells per cubic millimeter.

The sedimentation rate of erythrocytes was 75 mm in one hour, leukocytes numbered 11,000 and erythrocytes 4,360,000 per cubic millimeter of blood.

The otologist reported pulsating, creamy yellow pus in the left external auditory canal. The superior and posterior walls of the canal were drooping, and a roentgenogram of the left mastoid process showed cloudiness with evidence of destruction of the cell wall and a possible break in the tegmen mastoideum. A diagnosis of suppurative mastoiditis was made. Material obtained from the ear later and cultured was reported as growing *Streptococcus haemolyticus* and *Micrococcus*.

A neurologic examination made several hours after the patient's admission revealed nuchal rigidity and bilateral Babinski signs. An abscess of the cerebellum was suspected.

The next day the patient was more responsive and cooperative. Early weakness of muscles of the face was apparent on the right (the right corner of the mouth was lower than the left). Definite grasping weakness was not evident, but incoordination of the upper extremities, which seemed out of proportion to the general weakness of the patient, was present and was more evident on the right than on the left. Nystagmus was marked. The right knee jerk was more active than on the left, and the Babinski signs were positive bilaterally.

Despite the absence of definite localizing signs, exploration of the left temporal and left cerebellar lobe was decided on as the procedure of choice since the patient's condition continued to become worse.

The patient was comatose when brought to the operating room on April 30. He thrashed so that administration of a local anesthetic with the patient in a prone position was unsuccessful and pentothal sodium® was administered by the intravenous route. A burr hole was made in the temporal region on the left, and the lobe was explored. No abscess was encountered and the wound was closed. A straight incision was then made in the suboccipital region and on exploration of the left cerebellar lobe a mushy mass was encountered from which thick, greenish yellow pus escaped. This lesion had no true capsule. The meninges were sutured to the cortex and then sealed off with an electrosurgical unit. The abscess was opened wide and the ends of two pieces of rubber tubing were placed in the depths of the abscess. A strip of gauze was packed loosely around the tubes, and the wound was closed.

Immediately on return to his room, the patient died.

The bacteriologists reported that *Str. haemolyticus* was present in both the abscess and the brain tissue.

CASE 3—An unmarried white man, 48 years of age, was admitted to the hospital on March 25, 1940. The relatives gave a history of chronic otitis media of the left ear which had been present for approximately ten years prior to his admission. They related that one year previous to his admission he had suffered pain in the left ear which was accompanied by a discharge and by dizziness. The labyrinth of the left ear was reported "dead" at that time. The left ear, which drained intermittently, had been dry for three months prior to the admission of the

patient He had had influenza six weeks before admission, and three weeks later he had suffered severe pain behind the left eye and in the back of the head and neck The pain persisted to a variable degree At that time complete facial paralysis of the peripheral type occurred on the left side with nuchal rigidity The facial paralysis gradually diminished

Physical examination revealed a critically ill patient in a comatose state His temperature was 99 F, pulse rate, 108 beats per minute, and respirations, 20 per minute His blood pressure was 168 mm of mercury systolic and 98 diastolic Both tympanic membranes were scarred but discharge of the ears was not present and neither was there any swelling in the region of the mastoid portion of the temporal bone Nystagmus was present in all directions, the pupils were dilated and fixed Paralysis of the sixth and seventh cranial nerves was present on the left, and there was mild facial weakness on that side Kernig's sign was marked, and nuchal rigidity was present, all reflexes were hyperactive

Results of the caloric test showed a "dead" labyrinth on the left The leukocyte count was 13,750 and the erythrocyte count 4,450,000 per cubic millimeter of blood

The pressure of the cerebrospinal fluid was 33 cm of water, the fluid was cloudy and showed 3,600 polymorphonuclear cells per cubic millimeter Roentgenograms of the mastoid process showed evidence of complete sclerosis bilaterally A diagnosis of suppurative labyrinthitis, petrositis and leptomeningitis was made An emergency operation was performed the same afternoon

It was found that a large cholesteatoma had destroyed about 2 cm of the facial canal and had eroded the horizontal (semicircular) canal This was filled with a brownish substance A Newman type of labyrinthectomy was performed, and the labyrinth was found to be filled with thick pus and granulation tissue With the uncovering of the internal acoustic meatus, a mass of thick pus was discovered, and further investigation revealed that the entire posterior surface of the petrous apex had been destroyed The remaining part of the petrous apex was filled with pus which communicated with a large destroyed area on the dura and the adjacent surface of the left lobe of the cerebellum A cavity approximately the size of a large hen's egg was found in the left cerebellar lobe

The patient received a transfusion of 500 cc of blood while on the operating table Also, 300 cc of a solution of sulfanilamide was administered intravenously during the operation, immediately after operation 400 cc of the sulfanilamide solution was administered subcutaneously

The patient never regained consciousness after the operation and died at 3 a m, March 26 Organisms were not cultured from the blood or the cerebrospinal fluid The pus encountered during the operation was not cultured

CASE 4—A married white woman, 49 years of age, was first seen at the clinic on April 30, 1940 She gave a history of intermittent discharge of both ears which had been noted since 1930 In 1938 she noted unusual shifting pains in her head, which were present almost continuously but which were more intense at night In 1939, radical mastoidectomy was performed elsewhere on the left side According to the patient, she had pain in the left temporal region for the next seven or eight months During this period, a purulent fluid drained until some sequestered bone was removed In the latter part of 1939 an unusual "crackling noise" occurred in the occipital area, it occasionally recurred and later became constant Approximately two weeks before her admission, inter-

mittent drawing pains of both temporal areas began to extend posteriorly and to the top of the head. The patient also talked vaguely of other symptoms referable to the head.

Physical examination did not reveal any abnormalities except diffuse bilateral external otitis, which responded well to local therapy. Neurologic examination gave normal results. Later in the year (August 14) a psychiatrist evaluated the patient's condition as a mild compulsion-obsession state. After this had been discussed with her and her husband, she was dismissed. She returned for observation on Oct 29, 1942 and said that since she was last observed at the clinic there had been an occasional flareup of an inflammatory process which involved the external canal of the left ear and the mastoid area. This had responded well to local applications of heat and oral administration of sulfadiazine. She had also been under observation at a university hospital because of the multiple symptoms referable to the head. There the left carotid artery had been ligated in an attempt to relieve her of the unusual noises in her head.

Physical examination revealed rough and somewhat thickened skin over the left auricle and external auditory canal. The wall of the canal was noted to be pouting and had a defect which led into the mastoidectomy cavity. The ear was dry. Radical mastoidectomy was recommended. The dermatologic diagnosis of the cutaneous condition pertaining to the ear was chronic erysipelas. Oral administration of sulfadiazine was recommended before and after the operation.

The patient was hospitalized on October 30, and 15 grains (1 Gm) of sulfadiazine was administered every four hours before operation.

The patient was operated on November 2. It was evident that at the previous mastoidectomy the tegmen mastoides-tympanicum and the cerebellum were uncovered. Dense adhesions were present. Over the left cerebellar lobe there was a defect in the bone. The area of the defect was explored with the index finger and found to communicate with the cerebellar lobe. A cholesteatoma was found in the region of the middle ear and the attic. It was thought that an abscess was present, but no pus was encountered. A radical operation was performed. A Penrose drain was inserted into the cerebellum, and a petrolatum gauze pack was placed in the middle ear.

The administration of 15 grains (1 Gm) of sulfadiazine every four hours was continued for five days after operation. The petrolatum pack was removed on the third postoperative day. The Penrose drain was partially removed on the fifth postoperative day and completely removed on the seventh day. The hospital dismissal note, on November 9, recorded that only a small amount of purulent matter was being discharged from the ear. There was no evidence of erysipelas.

On November 21 the patient stated that she felt "very well." The posterior wound which led into the cerebellum was practically closed and the aural discharge was scant.

On Feb 23, 1943 the patient returned because of other symptoms, unrelated to those of which she formerly complained. The unusual sensations and noises formerly occurring in her head were not present. The cavity which resulted from the radical operation on the ear appeared in excellent condition.

CASE 5—A white man, 26 years of age, known to be diabetic, was hospitalized on Feb 13, 1938. At the time of his admission he stated that he had been well until about Feb 1, 1938, when he had a "cold." Subsequently an earache developed in his left ear. The left ear drained for about one week, but there was no drainage thereafter.

According to his history, the patient had registered at the clinic two years previously because of earache which had developed on the left side following an infection of the upper respiratory tract. At that time the patient was found to have nerve deafness as well as facial paralysis on the left side. A diagnosis of herpes zoster oticus was made. At that time he was also found to have moderately severe diabetes, which could be controlled with insulin.

About one week before he was admitted to the hospital, on February 13, the patient complained of headache, and the family noticed that he seemed drowsy. He was admitted to a hospital in his home town. There the patient continued to be drowsy, became nauseated and vomited on occasions, and became incontinent on several occasions. His parents stated that he had had a chill prior to entering the hospital at home.

On being admitted to the hospital here, the patient was found to be markedly dehydrated. He was stuporous but could be aroused. The oral temperature was 99 F, the pulse rate, 72, the respiratory rate, 18. He had a well healed post-mastoidectomy cavity on the right. Mastoid tenderness was not present on the left, and the external auditory canal was dry. There appeared to be a healed perforation of the ear drum with fulness of the peripheral part of the posterior wall and slight redness. Evidence of facial weakness was not present. However, conduction deafness was marked on the left.

Neurologic examination revealed nuchal rigidity of moderate severity. The Babinski sign was positive on the left, and there was incoordination on the left. There was coarse nystagmus in all directions. Choked optic disks were not revealed by fundoscopic examination, although there was a suggestion of early edema of the nerve heads. Most of the neurologic signs seemed to indicate a lesion of the brain stem on the left. The blood sugar determinations and the carbon dioxide-combining power of the blood were normal. The leukocytes numbered 11,600 per cubic millimeter of blood. Other laboratory procedures indicated normal conditions except for slight glycosuria. Increase of the pressure or of the number of cells in the cerebrospinal fluid was not evident.

The patient was observed for twenty-four hours, the stupor became more profound than on his admission and it was more difficult to arouse him. An emergency suboccipital craniotomy was carried out on the left side on February 14, and a large abscess of the cerebellar lobe was encountered and drained. A culture of the pus revealed *Str. haemolyticus*.

The patient's convalescence was satisfactory. He was dismissed from the hospital on March 16. The wound had healed, and the diabetes was under control. He returned for reexamination in January 1943. There had been no recurrence of symptoms referable to the abscess of the brain.

CASE 6—A white youth, 17 years of age, was admitted to the clinic on Aug 25, 1947. He complained chiefly of headache and drowsiness. According to his history, he had frequently had earache, first on one side and then on the other, since the age of 3. He apparently did well until Aug 2, 1947, when pain developed in the left ear. Apparently the last attack of earache prior to this episode occurred four years previously. There was no history of chills or fever, and the earache gradually subsided.

On August 9 the patient had a sudden severe headache which persisted. Throbbing pains began to develop in the back of the head and in the neck. Since August 13 he had complained of nausea and vomiting. One week prior to being admitted to the hospital here, he began to complain of numbness and paresthesias

of the left arm, hand and leg There had also been some dimness of vision, and for three weeks prior to his admission he had been receiving penicillin On examination he was found to be rather drowsy He complained of headaches and exhibited definite weakness of the left arm and leg Bradycardia was present, the patient was dehydrated

Neurologic examination showed weakness of the left upper and lower extremities with definite signs of incoordination, more pronounced in the upper than in the lower extremity Nystagmus was present in all directions Fundusoscopic examination showed choking of the optic disks of 3 diopters, with hemorrhages The visual fields were grossly normal All signs and symptoms indicated a cerebral lesion on the left Roentgenograms of the skull did not show any abnormality

On August 26, suboccipital craniotomy was carried out on the left side, and the contents of a large abscess of the left cerebellar lobe were evacuated and the capsule of the abscess was enucleated A catheter was inserted into the cavity from which the wall of the abscess had been removed Approximately 1 ounce of straw-colored fluid was aspirated from the abscess It was watery and looked similar to the fluid obtained from a cystic astrocytoma Culture of the fluid revealed no organisms Prior to the closing of the wound 100,000 Oxford units of penicillin was injected into the cavity Postoperatively 20,000 units was injected daily through the catheter In addition, the patient received 320,000 units intramuscularly on the basis of 20,000 units per cubic centimeter for eight days The catheter was removed at the end of the eighth day The patient's convalescence was satisfactory, and the wound healed by primary intention

Postoperative neurologic reexamination showed little ataxia, but the patient still had nystagmus and some incoordination on the left side Fundusoscopic examination revealed that the bilaterally choked optic disks had receded to 2 diopters on the left and 1 diopter on the right It was felt that the infection of the left mastoid process might well act as a nidus for a recurrent abscess Examination of the ears revealed normal canals, but the left canal contained pus There was a large perforation in the posterior inferior portion of the left ear drum from which pus was pouring, and the residual portion of the ear drum was thick and red

On October 10, radical mastoidectomy was performed on the left for acute hemorrhagic mastitis superimposed on chronic otitis media with cholesteatoma Postoperatively, the patient received 320,000 Oxford units of penicillin intramuscularly daily for eleven days The mastoid cavity healed well Subsequent fundusoscopic examination revealed further reduction of the degree of papilledema

The patient returned for reexamination on December 29 The left cavity was in excellent condition and completely epithelized Two to three weeks prior to his return the patient had had some pain in his right ear, but this had disappeared He has had no further recurrence of this pain, and apparently, at the time of this report, the abscess of the brain is not reforming

On Feb 1, 1948, a letter from the patient asked whether he might play basketball in the approaching winter He apparently was doing well, and there was no further correspondence with him

SUMMARY

Otogenic cerebellar abscess is very rare Sulfonamide drugs and penicillin properly utilized have markedly reduced the complications of acute suppurative otitis media

In the management of a cerebellar abscess of otitic origin, close cooperation between the otologist and the neurosurgeon is highly desirable. Since the abscess is otogenic, it is important to remove the primary focus either before, in conjunction with, or after, radical surgical treatment of the abscess.

The prognosis will be good when early diagnosis and accurate localization are followed by prompt and adequate surgical treatment and by administration of sulfonamide drugs and penicillin.

The administration of sulfonamide drugs and penicillin combined with radical surgical procedures on the brain and mastoid portion of the temporal bone promises to reduce further the morbidity and mortality which result from cerebellar abscess secondary to otitis media.

TINNITUS AURIUM IN OTOSCLEROSIS

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AND

MATTHEW S ERSNER, M D

PHILADELPHIA

TINNITUS aurium when it occurs in otosclerosis has unique features. It is constantly present in the active stage of the disease, and it disappears when the air conduction threshold reaches the 60-90 decibel loss level. In the presence of intact cochlear function, indicated by good bone conduction, the dependence of the head noises on a certain level of air conduction seems to suggest an extraneous origin of the tinnitus. The disease is almost always bilateral, but one side is involved to a greater degree than the other, and frequently the tinnitus is referred to one ear only. On the assumption that a "trigger sound" from the outside initiates the tinnitus, the localization of the sound to one side of the head may be explained by the Stenger phenomenon. The brain shifts the position of the sound toward the ear in which it is heard louder. Chart 1 presents the audiograms of otosclerotic patients with good bone conduction. In the first patient (*A*) there had been tinnitus in one ear or the other in the early stages of the disease, but during the past ten years the head noises disappeared. In the second patient (*B*) the right ear was the seat of the head noises for a very long time. During the year 1943, the tinnitus shifted from the right ear to the left ear suddenly. At that time the patient noticed an aggravation of the deafness in the right ear.

When tinnitus is due to a temporary condition, such as impaction of cerumen or inflammation of the middle ear, the head noises disappear promptly on the removal of the cause. In Ménière's disease, as illustrated in chart 2 *A*, the tinnitus ceased as soon as the patient's deafness became complete. It stands to reason that with the ablation of the function of the ear the head noises must disappear, provided no cortical factor is present.

Relief from head noises is frequently obtained by the use of a hearing aid. By virtue of its masking effect, a hearing aid is useful in cases of tinnitus associated with deafness, according to Saltzman and Ersner¹. In uncomplicated otosclerosis, the audicle is of greater value, usually, than in any other otologic entity, as regards both deafness and

From the Department of Otorhinology, Temple University School of Medicine.

1 Saltzman, M., and Ersner, M. S. *Laryngoscope* 57: 358, 1947

tinnitus We encountered an otosclerotic patient, however, whose head noise were greatly aggravated by the use of a hearing aid It appeared as though there might be something in the abnormal psychophysiology of otosclerosis that sometimes causes exaggerated sensitivity to extraneous sounds

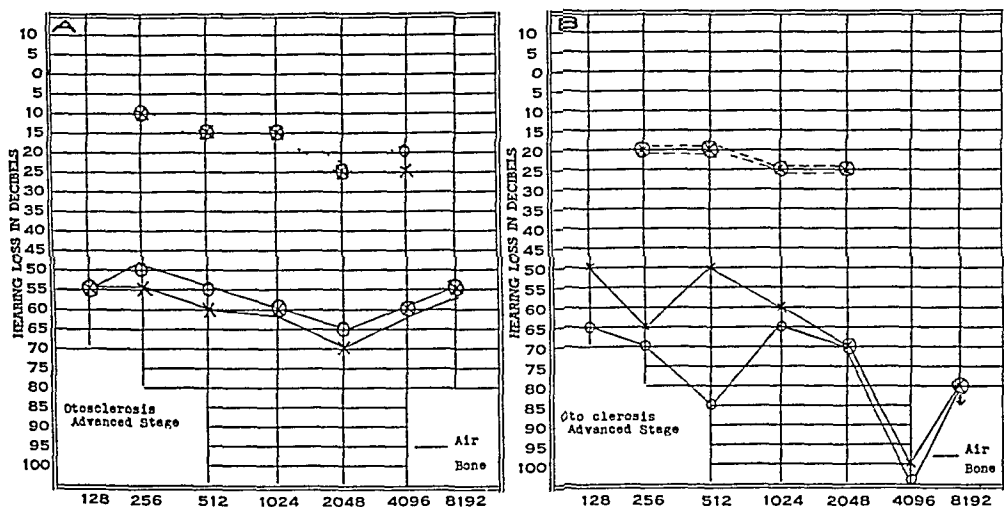


Chart 1—Audiograms of patients with otosclerosis in an advanced stage
Circles represent the right ear, crosses, the left

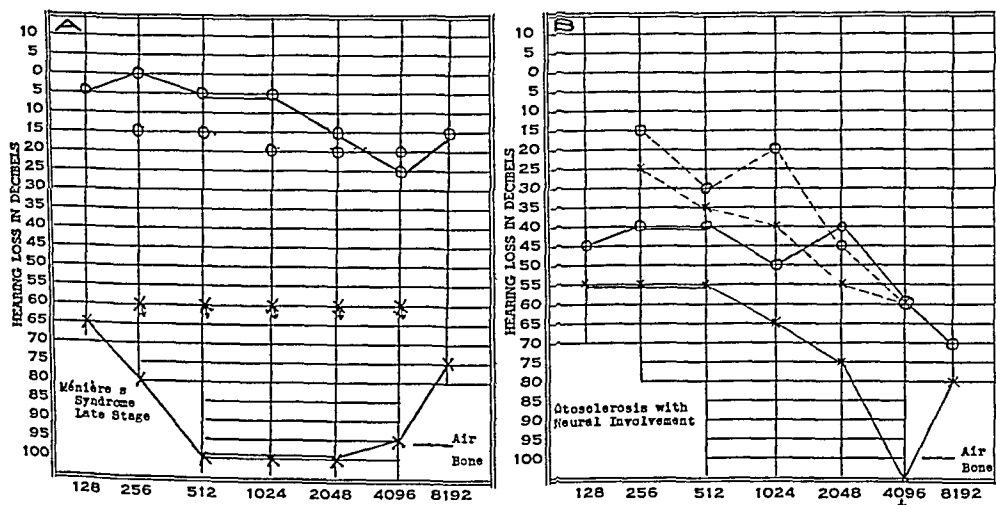


Chart 2—A, audiogram of a patient with Ménière's syndrome, late stage
B, audiogram of patient E W, aged 50, whose case is reported in this article
Circles represent the right ear, crosses, the left

REPORT OF A CASE

Mrs E W, aged 50 years, consulted us on Aug 4, 1948 Her complaints were ringing of the ears and progressive deafness dating back twenty-nine years She noticed an aggravation of her symptoms following pregnancy and childbirth Otoscopy and nasopharyngoscopy revealed no abnormality Results of

the Rinne test in both ears were negative, and her audiogram (fig 2B) was suggestive of otosclerosis with neural involvement. The left ear was selected for the wearing of a hearing aid, as it was the worse ear, with a 55-75 decibel loss for the speech frequencies. As the head noises were most severe in the left ear, it was hoped that the audicle would give the patient relief from tinnitus as well as an improvement in hearing. However, the wearing of the hearing aid in the left ear had a most unfavorable effect, the patient claiming an aggravation of the head noises. Furthermore, the patient stated that the wearing of the hearing aid for a few minutes caused persistence of unbearable tinnitus for several hours. It was suspected that a psychogenic factor played a part in this patient's complaints. Physical examination disclosed no abnormality. Her blood pressure was 120 systolic and 76 diastolic. There were no abnormal spontaneous vestibular manifestations, and the Kobrak caloric test gave normal responses. In order to divert the patient's mind from her left ear, a mold was made for her right ear and she was advised to wear her hearing aid on that ear. At present she is comfortably adjusted with the hearing aid on the right ear and claims to have "forgotten" her left ear.

COMMENT

As a rule, an audiologist advises the wearing of a hearing aid on the ear with a 55-75 decibel loss for the speech frequencies if the threshold of the other ear is at the 40-50 decibel loss level. It is also well recognized that an otosclerotic patient is easily fitted with an audicle. Most often tinnitus is favorably influenced by the use of a hearing aid. In our patient the reverse was the case. While a psychogenic factor might have been present, it is also possible that the "open air circuit hum" of the hearing aid, which is well tolerated by most people with an impairment of hearing, might have acted as a "trigger sound" in the left ear of the patient. From our study we feel justified in stating that in otosclerosis the damping power of the ear is impaired in respect to specific sounds and that some extraneous sounds have a trigger effect in the initiation of tinnitus in this otologic entity. It might well be that the "trigger stimulus" is a vibration at the lowest frequency of the hearing range and that the tinnitus is a harmonic of that tone. During a period of three years we questioned all the otosclerotic persons in our clinic regarding tinnitus. Invariably the head noises disappeared as soon as the air conduction threshold reached a high level even though cochlear function was good as evidenced by bone conduction. This phenomenon can be explained by the hypothesis that otosclerosis is characterized by an abnormality creating persisting harmonics from air-borne low frequency vibrations. When these tones are not heard, owing to a rise of threshold, the harmonics, which are termed tinnitus clinically, are no longer created.

1923 Spruce Street

1915 Spruce Street

Case Reports

RHINOPHYMA

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Rhinophyma is an infrequent lesion. Only a few paragraphs describing this condition are to be found in the standard textbooks of otolaryngology.

PREDISPOSING FACTORS

It is almost universally thought that the original condition of the skin is acne rosacea. Synonyms frequently used are "tooper's nose," "coppernose," "rum blossom" and "brandy face." Although alcoholism is frequently a predisposing factor, it was stated by Tulipan¹ to be so only indirectly. In his opinion, most, if not all, cases of rosacea are due to a deficiency of the vitamin B complex.

Acne rosacea is a chronic disease of the face characterized by hypertrophy and telangiectasia, often associated with acneform lesions and terminating in rare instances in pronounced hypertrophy of the tissues, particularly of the nose.

Early there occurs erythema, diffuse or in localized patches, which is transient and induced or made intense by exposure to cold or heat. The color of the skin in the affected areas varies from bright to dull red, or may be even purplish.

There is often an associated oily seborrhea, and the orifices of the sebaceous glands may be patulous or plugged with dry sebaceous secretion.

Only exceptionally the disorder progresses to what is termed the third stage. This is characterized by hypertrophy of the tissues, particularly of the nose which becomes enlarged, the glandular openings become conspicuous, oily seborrhea is marked, and the blood vessels are increased in number and size. The nose presents a dull red or purplish hue, which renders it conspicuous. Coincidentally, the tissue in the immediate vicinity and on the chin may be thickened, and the acneform lesions of the earlier stages may be present over other portions of the face. At times the hypertrophy produces lobulated masses, varying in size from that of a pea to that of a cherry. In rare instances, pendulous masses are produced. These may be limited in number or may be numerous and closely packed. When they are highly developed, an extremely disfiguring condition results, to which the term rhinophyma is applied.

Eggston² mentioned rhinophyma under fibromas and described the condition as being in the nature of scar tissue or keloid formation.

Rhinophyma is not so common as the parent disorder, which by no means invariably tends to such extreme alteration. The process may occur on the

¹ Tulipan, L. Acne Rosacea. A Vitamin B Complex Deficiency, Arch. Dermat. & Syph. 56:589 (Nov.) 1947.

² Eggston, A. A., in Nelson: Loose-Leaf Living Surgery of the Nose and Throat, New York, Thos. Nelson & Sons, 1946.

forehead or the chin (Sams³), but the nose is the site of predilection. Men are involved much more frequently than women. Ginsburg's⁴ patient was a woman.

PATHOLOGIC FEATURES OF RHINOPHYMA

The condition usually invades the inferior and anterior parts of the nose, it respects the free border of the alae nasi and decreases in severity from below upward, rarely extending beyond the glabellar region and the lateral border of the nose. It is characterized by irregular elevations, separated by fissures containing accumulated sebaceous masses. The nose has a somewhat violet hue, spotted by dilated veins. The soft tissues only are involved, the nasal bones, cartilage and nasal mucosa remaining intact.

Microscopically, one finds great hypertrophy of the sebaceous glands and considerable leukocytic infiltration, with many plasma cells. The epidermis generally remains uninvolved. The vessels of both the deep and the superficial layer of the corium are involved. Inflammatory changes are seen about the enlarged vessels and sebaceous glands. In some instances the hypertrophy predominates in the fibrous connective tissue. Occasionally the vessels are dilated, sometimes to a degree suggesting angioma.

When allowed to grow, rhinophyma can reach tremendous proportions, causing a great, repelling disfigurement. As in the case here presented, it may produce nasal obstruction and present a mechanical barrier to the placing of food in the mouth.

TREATMENT

The early treatment of rhinophyma lies in the hands of the dermatologist. Discussion here will be limited to the later treatment, after the tumor has progressed to considerable size and the patient anxiously seeks removal. Maliniak,⁵ in an excellent article, stated that treatment is far from uniform. He presented a case in which galvanocauterization was used, followed by extensive sloughing and necrosis of both alae nasi and the tip of the nose. He repaired the resulting nasal defect by suturing in a temporal flap.

Eminent authorities on radiotherapy agree that roentgen rays and radium seem to be of no real service in the treatment of rhinophyma.

Sutton and Sutton⁶ pointed out that in the milder degrees of connective tissue hyperplasia either multiple scarification or electrolytic puncture often does good, but in advanced cases resort must be had to more drastic measures. Reports by Grattan⁷ (1920), Maliniak⁵ (1931), Eller⁸ (1933) and others would indicate that the logical treatment is decortication. This can be done easily and

3 Sams, W. M. Rhinophyma, with Unusual Involvement of Chin, *Arch Dermat & Syph* **26** 834 (Nov) 1932.

4 Ginsburg, L. Rhinophyma in Woman, *Arch Dermat & Syph* **32** 468 (Sept) 1935.

5 Maliniak, J. W. Rhinophyma. Its Treatment and Complications, *Arch Otolaryng* **13** 270 (Feb) 1931.

6 Sutton, R. L., and Sutton, R. L. Jr. Diseases of the Skin, ed 10, St Louis, C. V. Mosby Company, 1939, p 1439.

7 Grattan, J. F. Rhinophyma. Cure by Plastic Operation with a Good Cosmetic Result, *J A M A* **74** 1450 (May 22) 1920.

8 Eller, J. J. Simple Procedure for Cure of Rhinophyma, *New York State J Med* **33**:741-743 (June 15) 1933.

simply by paring off the hypertrophic masses with a razor or scalpel. One must preserve a thin layer of subcutaneous tissue and fibrous membrane overlying the osteocartilaginous frame. The new epidermis provides a satisfactory result. Epithelization occurs from the growth outward of the deep glandular epithelium. If the surface is too glazy, it can be removed and a skin graft applied. Malmiak,⁵ however, stated the belief that the use of a Thiersch graft is unnecessary.

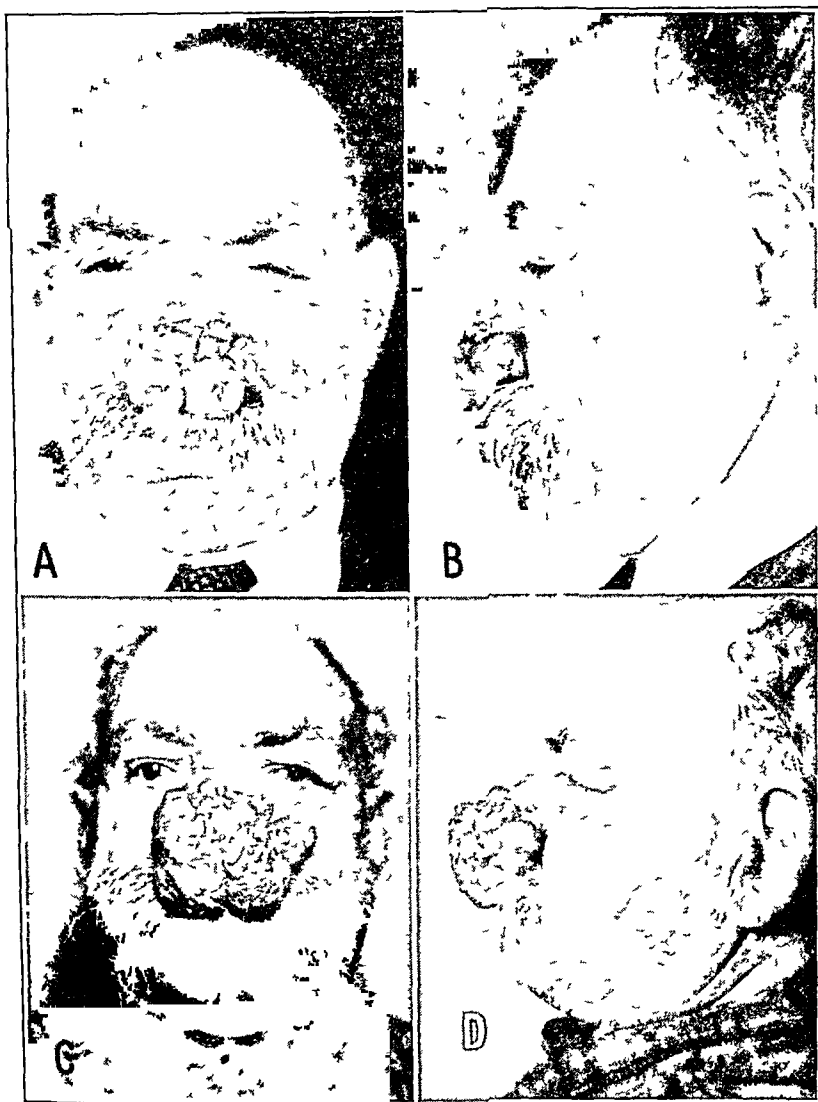


Fig 1—*A* and *B*, patient during first visit to clinic, in 1941, *C* and *D*, patient six and one-half years later, showing progression of lesion

REPORT OF A CASE

Mr F R, white, aged 65, an Italian-born fruit dealer and truck gardener, was first seen on May 23, 1948, at the Syracuse Free Dispensary. The chief complaints were a disfiguring growth of the nose, nasal obstruction from the overhanging mass, partial oral obstruction and a bothersome visual obstruction

when he was supine. He came to this country at the age of 13. He stated that during 1927 he had had a swollen, red nose. From a carefully detailed history, one may assume that he had acne rosacea. Twelve months later (1928) he noted a small pimple on the tip of the nose. After three weeks he tried several ointments, with no relief. The lesion continued to grow, and several small, hard, granular masses formed around the original pimple. In 1941 he considered removal of the mass. After having a work-up in the dermatology

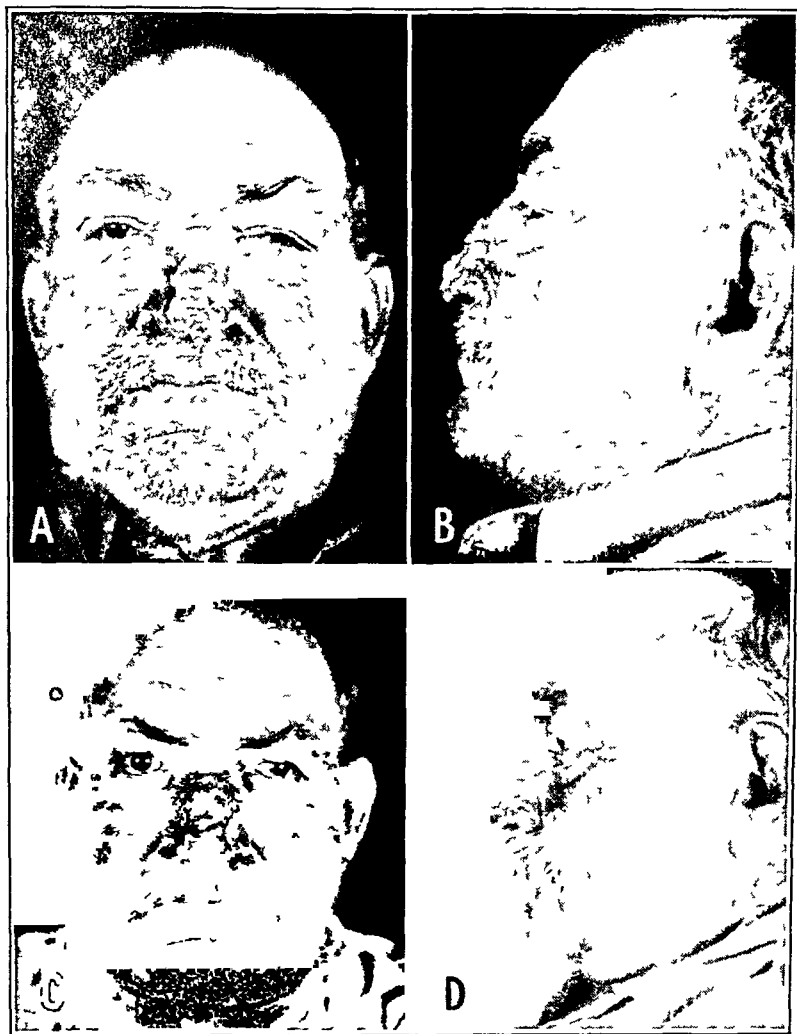


Fig 2—*A* and *B*, patient twenty-five days after operation. The area of granulation tissue was treated with trichloroacetic acid, *C* and *D*, patient sixty-three days after operation.

clinic, which included the taking of photographs (fig 1*A* and *B*), he refused treatment. There was no family history of a similar condition. He had been a moderately heavy wine drinker his entire adult life.

Physical examination revealed a large, multilobular, brownish-blue lesion, involving the entire soft part of the nose from the junction of the nasal bones

and the upper lateral cartilages. The mass was approximately the size of a tennis ball and was pendulous in two discrete portions, which hung down over the nares and most of the mouth (fig 1 C and D). Many of the nodular lesions were discrete and separated by definite fissures, which were filled with yellowish white, foul-smelling debris. By lifting the lesion, one could see that the free borders of the alae nasi were not involved. The mucosa appeared normal except in the right vestibule, where a portion of the mass had protruded between the upper lateral and the tip cartilage, leaving the mucosa mounded and blanched. Examination of the ears, mouth and throat revealed nothing remarkable.

Treatment—After twenty-four hours of penicillin therapy (400,000 units) operation was performed, on May 28. Local anesthesia was used in the same manner as for rhinoplasty. Infiltration with a 1 per cent solution of procaine hydrochloride and application of a 10 per cent solution of cocaine hydrochloride

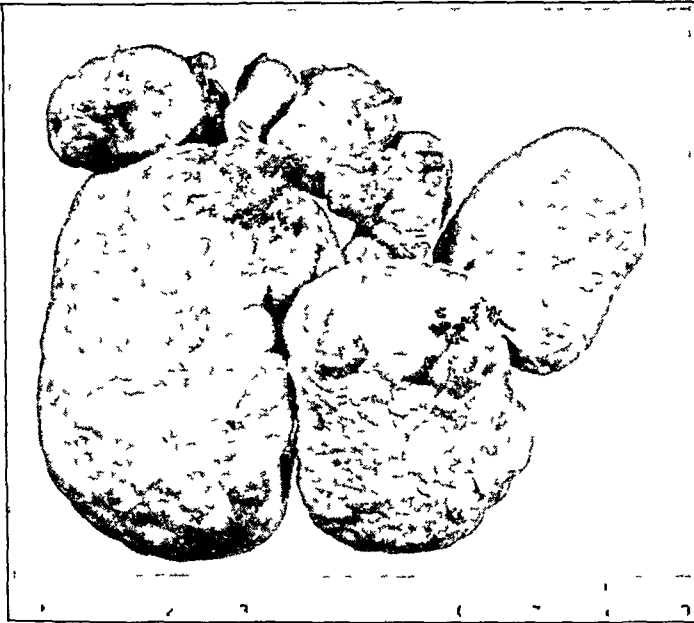


Fig 3—The mass after removal

to the nasal mucosa proved satisfactory. The lesion was removed with a razor blade. The entire area was decorticated to the thin subcutaneous tissue overlying the osteocartilaginous framework. In the area between the upper and the lower lateral cartilage on the right side, a large section was excised, exposing both cartilages. On removal of the major portion of the lesion, the remaining bed appeared irregular and bumpy. This was shaved down carefully, and a small portion of the subcutaneous tissue of the adjacent (normal) skin was removed to prevent an irregular, raised junction line. Four pieces of absorbable gelatin sponge (gelfoam®) soaked in 5 cc (200,000 units) of penicillin solution were placed over the operative site. A small rubber tube (Dakin), wrapped in petroleum jelly gauze, was inserted into each naris and the tubes were sutured together, external to the columella. A pressure bandage was then applied over the nose.

The pressure bandage and the Dakin tubes were removed forty-eight hours after operation, leaving just the gelfoam® cap over the nose. There was no

bleeding After receiving 300,000 units of penicillin daily for five days, the patient was released from the hospital, on June 2 On June 12, the edges of the dark (gelfoam®) pack were loose and beginning to separate Two days later the cap was easily lifted from the nose in one piece, leaving a dry bed, except for an area of granulation tissue on the right side The first postoperative photographs were taken on June 22 (fig 2*A* and *B*) The area of granulation tissue was treated with trichloroacetic acid



Fig 4—Section of the lesion, showing pronounced hypertrophy of sebaceous glands, with formation of a sebaceous cyst ($\times 55$)

The lesion after removal and a photomicrograph of the tissue are shown in figures 3 and 4 The pathologic report conforms to the previously mentioned description of rhinophyma Photographs taken on July 30 (sixty-three days after operation) are shown in *C* and *D* of figure 2 Arrangements were made for the patient to enter the hospital in October for removal of a small amount of scar tissue over the right tip of the nose, and for the placement of a Thiersch graft

SUMMARY

Rhinophyma, an infrequent end result of acne rosacea, is occasionally seen and should be treated by the otolaryngologist

Although several methods of treatment have been stressed, decortication of the hypertrophic masses by means of a razor blade or knife is simple, effective and logical

The use of penicillin-soaked absorbable gelatin sponge gelfoam® proves most beneficial in the control of postoperative hemorrhage and infection

The use of intranasal Dakin tubes wrapped in petroleum jelly gauze allows free nasal breathing and permits the use of firm pressure over the dressing without discomfort to the patient

Department of Otolaryngology, Syracuse University

ABSCESS OF THE BRAIN FOLLOWING TONSILLECTOMY AND ADENOIDECTOMY

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AND

ROYAL REYNOLDS, M D

WASHINGTON, D C

INTRACRANIAL complications of infection of the tonsils and adenoids have been fully discussed by Hara and Courville¹ In their survey of the literature from 1900 to 1940, they recorded the incidence of intracranial complications of tonsillar origin as follows

Thrombosis of lateral sinus	4
Thrombosis of cavernous sinus	43
Encephalitis, cerebral abscess	13
Embolism	7
Total	<u>67</u>

In only 7 of these cases did the complication follow operation on the tonsils and adenoids, in the majority it resulted from tonsillitis or peritonsillar abscess The rarity of cerebral complications of operations on the tonsils and adenoids is evident from other statistical data cited by Hara and Courville In 25,000 autopsy records in the Los Angeles General Hospital only 1 instance of intracranial disease of tonsillar origin was found

Letherwood,² in a series of 10,000 cases of tonsillectomy, cited 1 case, that of purulent meningitis developing in a child Chisolm and Watkins³ found 8 cases of thrombosis of the cavernous sinus among 50,000 surgical records, but in no instance was the condition of tonsillar origin Nesbitt,⁴ in his review of postoperative complications in 1,457 cases, mentioned 1 case of meningitis following tonsillectomy and adenoidectomy

Many similar references in the literature could be cited to make obvious the fact that even though the tonsils and adenoids are frequently the source of infection and the tonsillar and postnasal spaces are often traumatized during tonsillectomy and adenoidectomy, the pathways to the brain are invaded only on the rarest occasion and, fortunately, intracranial complications are extremely rare Because of this fact, otolaryngologists are inclined not even to think of cerebral abscess as a postoperative complication of tonsillectomy and adenoidectomy, certainly not to the extent that abscess of the lung is so considered

1 Hara, H J, and Courville, C B Intracranial Complications of Tonsillar Origin, with Special Reference to Their Incidence and Pathogenesis, Arch Otolaryng 35 530 (April) 1942

2 Letherwood, T F Complications Following Tonsillectomy, J Tennessee M A 21 272 (Nov) 1939

3 Chisolm, J J, and Watkins, S S Twelve Cases of Thrombosis of the Cavernous Sinus from a Study of Fifty Thousand Surgical Histories in the Johns Hopkins Hospital, Arch Surg 1 483 (Nov) 1920

4 Nesbitt, B E Post-Operative Complications and Results of Tonsil and Adenoid Operations in Children, Brit M J 2 509 (Sept 15) 1934

The report of a case of abscess of the brain developing five days after tonsillectomy and adenoidectomy is warranted in view of the paucity of similar reports in the literature. This case has particular significance in that it occurred during the poliomyelitis season, although at the time there was no epidemic, only an isolated case having been reported in Washington, D C

REPORT OF A CASE

The patient, a rather frail boy, had been in good health except for yearly attacks of acute tonsillitis. He had had measles at the age of $4\frac{1}{4}$ years and had been immunized against diphtheria, smallpox, whooping cough and typhoid.

Prior to operation on May 30, 1947, he was given a careful physical examination, and the only abnormal conditions found were hypertrophied and infected tonsils, cervical lymphadenitis and underweight.

The boy had sustained a slight bump on the head about a month before, which the mother said had caused a "knot." This was not a wound or an infection, and the child required no medical care for this injury, which was not regarded as a significant cause of the cerebral lesion.

The temperature was normal, and the blood count, urinalysis and other routine preoperative examinations revealed nothing abnormal. The operation was without unusual incident, and the child's reaction and convalescence during the subsequent five days showed no significant indication of trouble. The throat healed well, and the postoperative exudate disappeared in the usual time. The temperature was between 99 and 100 F. On the fifth postoperative day he complained of headache and displayed abnormal lassitude and general weakness, followed by persistent vomiting. He became drowsy, and a slight rigidity of the neck was noted. The knee jerks were active, and the suggestion of a Babinski reflex was present, but at first there was no muscular weakness or atrophy. Facial paralysis later developed. The pupils reacted sluggishly to light, and the left pupil was larger than the right. There was some weakness of the muscles of the right shoulder girdle, in fact, the weakness was more pronounced in the upper and lower extremities on the right side. There was no weakness of the intercostal, pharyngeal or abdominal muscles. The spinal fluid was turbid and "poured out of the needle in a stream," indicating increased pressure. The reports of the spinal fluid were as follows:

June 10 The spinal fluid was clear and contained 60 mg of protein and 40 to 50 mg of sugar per hundred cubic centimeters and 50 leukocytes per cubic millimeter, with a differential count of 35 per cent polymorphonuclear leukocytes and 65 per cent lymphocytes.

June 12 The spinal fluid was cloudy and contained 40 mg of protein and 45 mg of sugar per hundred cubic centimeters and 400 leukocytes per cubic millimeter, with a differential count of 51 per cent polymorphonuclear leukocytes, 26 per cent lymphocytes and 23 per cent endothelioid cells.

June 13 The spinal fluid had a milky, turbid appearance and contained 200 mg of protein and 40 mg of sugar per hundred cubic centimeters and 1,060 leukocytes per cubic millimeter, with a differential count of 65 per cent polymorphonuclear leukocytes, 22 per cent lymphocytes and 13 per cent endothelioid cells.

The smear of the spinal fluid showed no organisms and culture yielded no growth. Several blood cultures were sterile. Other laboratory tests revealed no significant features except for persistent leukocytosis. The temperature ranged from 99.2 to 102.6 F, but prior to his death, on June 14, it rose to 105.8 F.

During the course of the illness the patient was given penicillin and sulfadiazine, without benefit, and, as a diagnosis of poliomyelitis was made, he was placed in a respirator. Death occurred on the fifteenth day following the tonsillectomy and adenoidectomy.

Autopsy Observations—Autopsy disclosed an abscess of the left frontal lobe of a diffuse type and without a definite capsule. There was no sign of a previous injury to the skull or to the brain. Examination of the mastoid cells, nasal accessory sinuses and other body structures disclosed no source of infection.

COMMENT

This case is of particular significance, as it followed tonsillectomy and adenoidectomy during the infantile paralysis season and a diagnosis of poliomyelitis was made—a reasonable conclusion considering the neurologic findings. The autopsy alone disclosed the true nature of the cause of death. The case suggests the possibility that conditions diagnosed in the past by others as poliomyelitis following tonsillectomy and adenoidectomy may have been intracranial complications of different causation.

1830 I Street, N W

OSTEOMA OF THE TONGUE

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True osteomas occur rather frequently in the bones of the skull and involve the sinus cavities. Osteoma of the tongue is a rare condition. Seven cases have previously been reported. The eighth case is now presented.

REPORT OF CASE

Mrs M W, a white housewife, age 30, was admitted to the migraine clinic of Montefiore Hospital, on Dec 23, 1946. Her chief complaints were headache, postnasal discharge and a tendency to gag and vomit. These had been present for several months. There was no history of pain or difficulty in swallowing. On Jan 23, 1947, she was referred to the ear, nose and throat clinic for consultation. At that time the patient stated that six days previously she had felt with her finger a mass at the back of her throat.

Examination revealed no abnormalities except of the tongue. At the middle of the right limb of the V formed by the circumvallate papillae, a rounded mass about 1 cm in diameter was attached to the tongue by a short, broad pedicle. The mass was removed with the area under local anesthesia, slight bleeding was easily controlled with pressure. The laryngopharynx was normal.

Roentgenograms of the skull were taken. The report read as follows: "There are no abnormalities of the bones of the vault. The sella turcica is of normal size and contour. There is no evidence of abnormal intracranial calcification."

The patient was examined one week after removal of the mass. The tongue was completely healed. Palpation failed to reveal any other masses at the base or in the substance of the tongue. Mirror examination of the base of the tongue and the laryngopharynx revealed no abnormalities, but the patient still had the same tendency to gag and vomit as before removal of the growth.

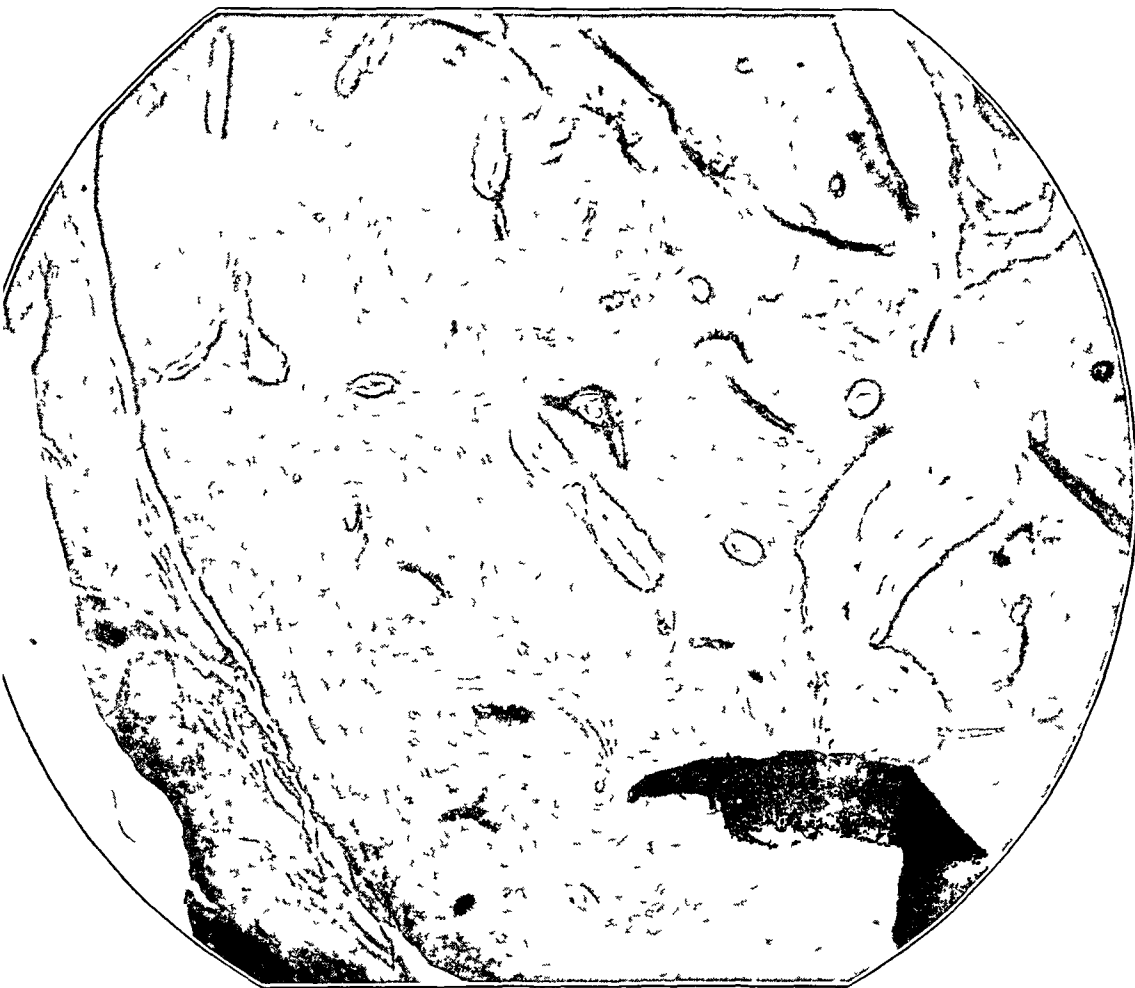
The pathologic report read as follows: "The specimen consists of a hard mass about the size of a pea from the region of the circumvallate papillae. Macroscopic examination revealed that the specimen was an irregular nodule, measuring 8 by 6 by 3 mm. It was bony hard and had to be cut with a saw. It consisted of a central grayish mass, having the appearance of dense bone enclosed by a thin shell of firm grayish white tissue less than 1 mm thick. Microscopic examination shows the central mass to be compact bone of normal architecture enclosing a few marrow spaces containing loose fibrous tissue, which shows slight focal small round cell infiltration and which is covered with nonkeratinizing stratified squamous epithelium (the figure). The diagnosis is osteoma."

From the Oto-Laryngological service of Dr A A Schwartz, Montefiore Hospital for Chronic Diseases

REVIEW OF THE LITERATURE

Greig¹ reviewed the literature and cited cases previously reported by Monserrat, Hirsch, Zuckermann and Neumark and Herzog. In addition to these cases, 3 others have been reported, by Jung,² Magnien and Perrot³ and Muta and Ogata.⁴ The present case is the eighth to be reported. Information is available on 7 of the cases. Some of the salient features are indicated in the table.

It will be noted that in all 7 fully reported cases the lesions occurred in women. Their average age was 33 $\frac{1}{4}$ years. Symptoms either were absent,



Area of bone and epithelial covering, $\times 60$

1 Greig, D. M. Osteoma of the Tongue, *Edinburgh M. J.* **39** 93-104 (Feb.) 1932

2 Jung, G. Osteoma of the Tongue, *Beitr. z. klin. Chir.* **154** 167-168, 1931

3 Magnien and Perrot, M. Osteoma of the Tongue, *Ann. d'anat. path.* **10** 331-334 (March) 1933

4 Muta, T., and Ogata, K. Osteoma of Root of Tongue. Case, *Oto-rhino-laryng. (Japanese)* **11** 1016-1017 (Nov.) 1938

the tumor being discovered accidentally, or consisted in slight discomfort, irritation or tendency to gag. All lesions occurred on the posterior third of the tongue. Four of the 7 were pedunculated, 1 was embedded, 1 was sessile and the form of attachment of the other was not stated. In the cases in which the pathologic observations were recorded the tumor was characterized by adult bone formation. Treatment consisted in surgical removal, with or without cauterization of the base of the growth. The operation was simple, and invariably successful (no complications were mentioned).

Fibroma of the tongue is a tumor of moderate vascularity and slow growth, occurring primarily on the anterior two thirds of the tongue. Osteoma occurs only on the posterior third and base of the tongue. Two theories have been advanced to account for the formation of osteomas. The first is that they are a result of bony rests, the second, advanced by Greig,¹ is that an osteoma occurs from degeneration of a fibroma and that those fibromas which arise on the posterior third of the tongue turn into osteomas. According to Greig, the lessened motility

Some Salient Features of Previously Reported Cases of Osteoma of the Tongue

Author	Sex of Patient	Age	Symptoms	Location	Form of Attachment
Monserrat ⁵	F	32	None	Postmesial	Pedicle
Hirsch ⁵	F	26	Difficulty in swallowing	Dorsum of root	Not stated
Zuckermann ⁶	F	30	None	Posterior	Pedicle
Neumark and Herzog ⁵	F	58	Difficulty in swallowing	Left vallecula	Pedicle
Jung ²	F	22	Irritation of throat	Both sides of foramen cecum	Embedded
Magnien and Perrot ³	F	37	Discomfort in swallowing	Posterior third	Sessile
Witchell Muta and Ogata ⁴	F	30	Tendency to gag (No Information)	Posterior third	Pedicle

of this part of the organ is the necessary factor in the change from fibrous tissue to bone. On the pharyngeal portion of the tongue active movements are more restricted, the parts are more fixed anatomically, and a tumor of this portion has little to rely on beyond its own inherent circulation to maintain its metabolism. It degenerates more readily, and with this degeneration comes the deposition of calcium salts. Calcareous salts in this form and quantity act as an irritant, which in time provokes revascularization, during which the calcium is resorbed, changed to its colloidal form and utilized to form heterotopic bone. If there is contraction of the fibrous tissue, the bone becomes consolidated and as dense as ivory.

Monserrat ⁵ in 1913 reported a case of osteoma occurring in a 32 year old woman. The tumor was about the size of a cherry and as hard as ivory, decalcification was slow and tedious. It produced no symptoms but was accidentally discovered on routine laryngoscopic examination. It arose by means of a pedicle in the mesial plane, about 2 to 3 mm posterior to the sulcus terminalis linguae. The pathologic report on the specimen read as follows: "Microscopic examination showed normal osseous tissue in which the Haversian canals were few and narrow. The lamellae were arranged in large circular or ovoid systems with few bone

⁵ Cited by Greig ¹

cells This ivory tumor was surrounded by a thin layer of fibrous connective tissue, as with a thick periosteum, and over all lay the normal epithelium of the lingual surface"

Hirsch⁵ in 1925 reported a case of osteoma in a woman, aged 26, who complained of difficulty in swallowing Examination revealed a tumor somewhat larger than a cherry on the dorsum of the root of the tongue The tumor was removed by snare and was found to be bony hard throughout Microscopic examination revealed it to be bone covered with lingual epithelium

A third case of osteoma was reported by Zuckermann⁶ in 1929 It was discovered accidentally in the course of a routine examination The patient's only complaint was of a sensation of a foreign body at the base of the tongue for about a month Laryngoscopic examination showed the tumor to be dependent from the region of the vallate papillae, a little to the left of the midline, hanging in the vallecula between the root of the tongue and the epiglottis The mass was removed by snare under local anesthesia Examination showed the tumor to be about the size of a pea, with a long stalk and a smooth superficial surface, in density it resembled bone Microscopic examination revealed that the tumor was composed of bone, whose lamellas were packed close together, with very narrow haversian canals and bone spaces

The fourth case, reported by Neumark and Herzog,⁵ was one in which a definite osteoma was associated with cartilage The lesion occurred in a woman aged 58, who had had difficulty in swallowing for several weeks The tumor was the size of a walnut, yellow on the surface, with definitely dilated blood vessels, and appeared to be contained in a thin capsule of connective tissue It arose by a relatively narrow pedicle from the left vallecula and had caused dysphagia by depending toward the esophagus No explanation was given for the presence of both cartilage and bone in the same capsule

Jung,² in 1931, described a case of osteoma of the tongue of a female student aged 22 She complained of an irritation of the throat Laryngoscopic examination revealed a hard symmetric swelling on each side of the foramen cecum Both growths were removed under local anesthesia, and each mass was found to consist of lamellar bone with haversian systems and a marrow cavity Each tumor was enveloped in fibrous tissue and covered by normal mucosa Jung stated that he favored the embryonic theory of detachment of a portion of the hyoid bone or mandibular arch as a cause of formation of osteoma

Magnien and Perrot³ described a case of osteoma in a woman aged 37, whose only symptom was discomfort on swallowing A pale pink sessile tumor about the size of a large pea was discovered on the surface of the tongue slightly behind the junction of the posterior third and anterior two thirds Pathologic examination revealed the characteristic structure of adult compact bone The authors could give no reason for the formation of the tumor

SUMMARY

A case of osteoma of the tongue is reported The rarity of this condition is evidenced by the fact that only 7 other cases are reported in the literature It is noted that in all reported cases the tumors occurred in women, and all were on the posterior third and root of the tongue

2020 Grand Concourse, Bronx 53, New York

6 Zuckermann, M Osteoma of the Tongue, *Ztschr f Hals-, Nasen- u Ohrenh* 25 118-120 (Nov 14) 1929

CICATRICAL STENOSIS OF THE HYPOPHARYNX TREATED WITH SKIN GRAFT

ROBERT B ROBERTSON, M D
BOSTON

THE CASE to be described is one of stricture of the hypopharynx following ingestion of lye which did not respond satisfactorily to bougienage. A successful result was brought about by applying the principles of plastic surgery. Through an external approach a skin graft was applied to the cicatrized area after resection of the stricture.

Since 1918, skin grafts have been successfully applied onto freshly denuded surfaces in the presence of salivary secretions, which contain the bacterial flora of the mouth. At that time Waldron, Gillies and Pickerill¹ introduced a stent with the skin graft directly into the mouth. Arbuckle,² in 1930, was among the first to report the application of free skin grafts to laryngeal stenoses. Figi,³ in 1947, reported that he applied this technic to cicatrized laryngeal stenoses with success.

REPORT OF A CASE

A Negro woman aged 20 had ingested lye in a suicidal attempt. She was first seen in the ear, nose and throat clinic of the Gorgas Hospital several weeks afterward, in June 1947, with dyspnea and emaciation. Examination with the laryngeal mirror revealed the hypopharynx to be closed by cicatricial tissue except for an opening so small that no part of the larynx could be visualized. Two to 3 mm of epiglottis projected above the stricture, the remainder was assumed to be involved in the formation of the scarred bands. On June 26 tracheotomy became necessary, and within a few days gastrostomy was performed for nutritional purposes. From that time until October, several attempts were made to enlarge the opening in the cicatrized hypopharynx. Thiopental sodium U S P (pentothal sodium®) was used for general anesthesia, followed by gradual dilation with laryngeal dilators. The results were not gratifying, the tracheotomy tube could not be closed completely for more than a day or two, owing to the return of the stricture.

In December it was decided to resect the stenosed area through an external approach and apply a skin graft to it. On December 19, with gas, oxygen and ether administered through the tracheotomy tube, an anterior midline incision was made, similar to the one utilized in a standard procedure for laryngofissure. The neck was extended and the incision made from the hyoid bone to the cricoid cartilage and carried down to the laryngeal cartilages. The larynx was entered through the thyrohyoid membrane, and the thyroid cartilage was divided in the

From the Eye, Ear, Nose and Throat Service of the Gorgas Hospital, Panama Canal Zone

¹ Waldron, Gillies and Pickerill, cited by Padgett ⁴

² Arbuckle, M F. The Cause and Treatment of Cicatricial Stenosis of the Larynx, *Ann Otol, Rhin & Laryng* **39** 134-143 (March) 1930

³ Figi, F A. The Etiology and Treatment of Cicatricial Stenosis of the Larynx and Trachea, *South M J* **41** 17-25 (Jan) 1947

midline from top to bottom. All the laryngeal structures were intact and appeared to have escaped injury from the offending lye except for the epiglottis. This structure was involved in the formation of the stricture, which was apparent in the immediate supraglottic region (fig 1). For better exposure, the hyoid bone was divided in the midline and the base of the tongue incised until the whole cicatrized area, as well as a space above the stricture, was clearly exposed. The involved area, *in vivo*, measured approximately 2 cm and consisted of bands of varying density. Only the lowermost portion was patent, it admitted the tip of the small finger. The small aperture as noted from above on admission had closed. The involved region was completely excised by blunt and sharp dissection,



Fig 1—Sagittal section of the neck showing the cicatrized area and the manner in which the epiglottis was involved

and oozing, although troublesome, was controlled by epinephrine tampons alone. Survey of the field then revealed a lumen which was entirely adequate. All scar tissue had been removed, including remnants of the epiglottis, and the freshly denuded area measured approximately 3 cm in length. The lateral piriform fossae were obliterated, however, the little finger could be introduced about 2 cm, and a urethral catheter about 8 cm, into the esophagus. It was evident that much of the esophagus must be closed because of strictures. A piece of air foam sponge rubber,[®] roughly shaped before sterilization, was trimmed to fit into the prepared area (fig 2). A tip of the sponge was left projecting from the lower end to fit into the esophagus to help maintain fixation. The sponge, therefore, projected

onto normal mucosa both above and below the freshly denuded hypopharynx. Being 3 cm in diameter, the sponge was snug enough to provide hemostasis and assert a certain degree of fixation, at the same time maintaining the skin graft firmly against the prepared surface. Padgett⁴ stated that in applying skin grafts to cavities allowance must be made for a considerable amount of subsequent contracture and that, therefore, the cavity must be overdistended by the mold. From the left thigh a Thiersch graft 0.25 mm in thickness, without hair, was cut with a dermatome. It was thought that a better "take" might be obtained with this thinner graft and yet sufficient protection be given the hypopharynx, where

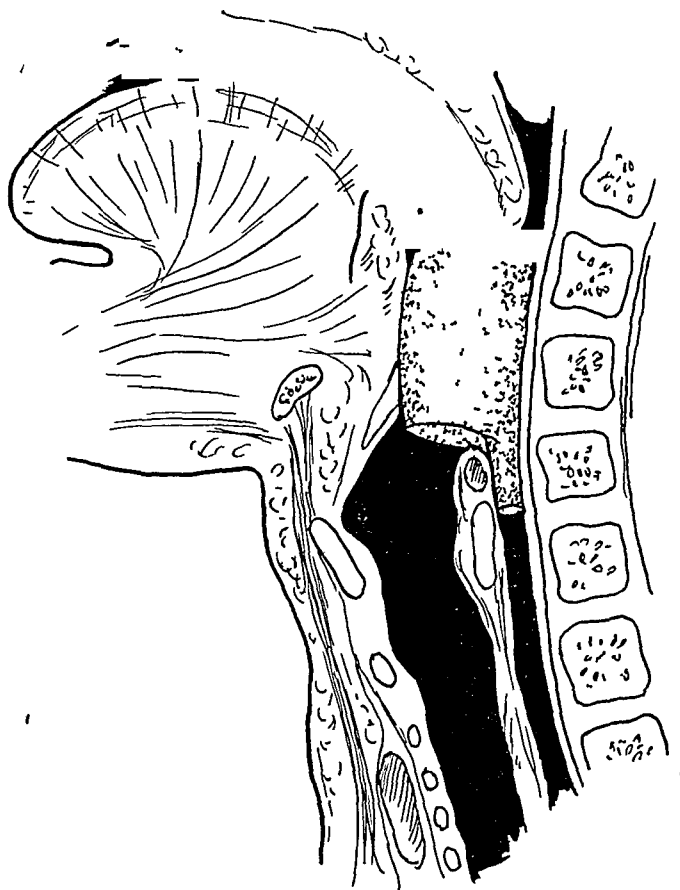


Fig 2—Sagittal section of the neck illustrating the position of the sponge stent after the strictures and part of the epiglottis had been excised

trauma, at most, is mild. The graft was then draped over the previously fitted sponge, with the raw surface outward, and trimmed to the same circumference as the sponge, but with the ends overlapping it. The whole was then inserted into the hypopharynx, so that the projecting tip protruded into the esophagus. The edges of the graft were lifted from the sponge and sutured to the deep margins of the incision on either side with several interrupted atraumatic 0000 plain surgical gut sutures (fig 3a). A piece of German silver wire was passed through the tissues of the neck on one side of the incision, carried through the sponge and graft and

⁴ Padgett, E. C. *Skin Grafting*, Springfield, Ill., Charles C. Thomas, Publisher, 1942, p. 70.

brought out onto the opposite side of the incision (fig 3b) to protect against expulsion of the sponge and, possibly, the Thiersch graft. Plain 00 surgical gut was used to close the various subdermal layers, and silk was used to close the skin. The wire was anchored by squeezing a slit lead shot onto either end adjacent to the skin. A small fascial drain was left in place for twenty-four hours.

The patient was given 30,000 units of penicillin every three hours for the one day previous to and the three days after the operation. No special diet was given, nor was oral asepsis attempted after operation. Healing occurred by first intention. The sutures were removed on the fifth and sixth postoperative days and the wire

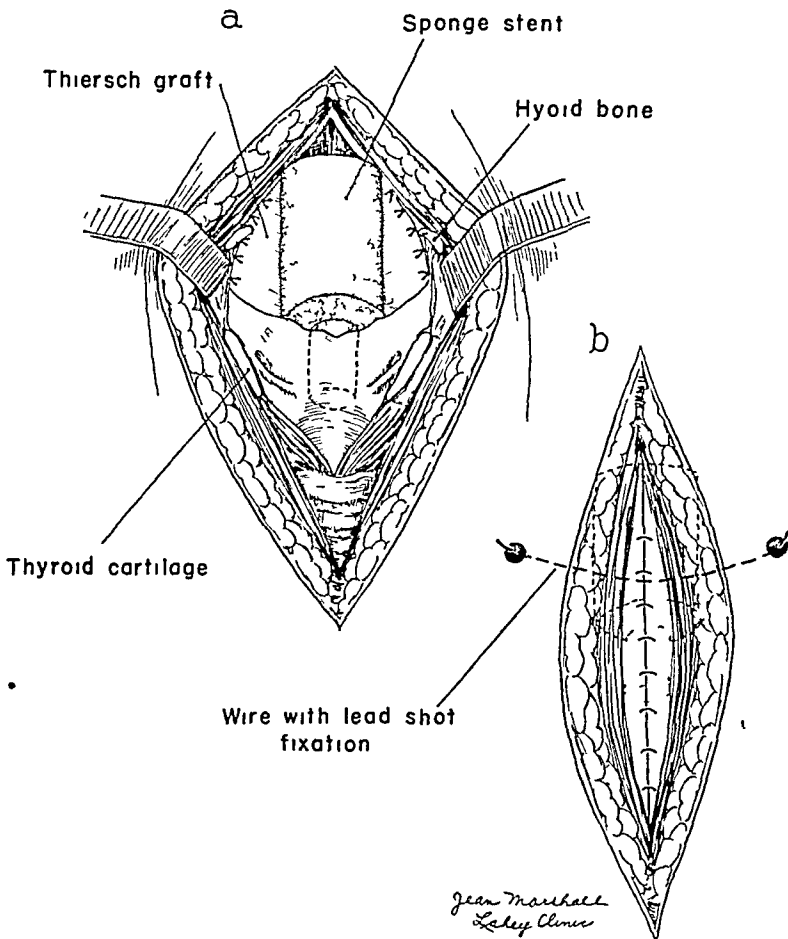


Fig 3—(a) Anterior view of sponge stent in position and skin graft anchored by fine sutures at deep margins of the incision. The tip of the sponge projects into the postarytenoid region. (b) Anterior view illustrating the position of wire anchor held in place by lead shot. The innermost layer has been closed.

was removed on the eighth day. Plans were made to remove the sponge from above, using the laryngoscope, however, the sponge was expelled shortly after the removal of the wire. The patient assumed a normal speaking voice immediately, and no dyspnea was evident once the tracheotomy tube was closed off. Examination with the mirror revealed that much of the graft was adherent except for small strands at the free margins. The opening was as large as a normal hypopharynx, and the vocal cords were normal and moved well. The tracheotomy tube was removed a week later.

On Jan 20, 1948, about a month after the graft had been applied, direct laryngoscopy revealed about a 90 per cent "take." The diameter of the lower part of the pharynx had diminished about one fourth as compared with the diameter immediately after operation. The field was clean and the graft adherent. Excess, overlapping strands of skin, noted in the previous examination, were absent, and the skin graft and adjacent mucosa were confluent. This examination was carried out with thiopental sodium after the larynx had been sprayed with 10 per cent solution of cocaine. Immediately afterward an attempt was made to dilate the esophagus, which also had several strictures as a result of the lye burn that had been demonstrated by barium relief while the hypopharynx was still patent. A McGill endotracheal tube was inserted and a no. 5 Jackson esophagoscope was passed to the cricopharyngeal area. As a result of the presence of both the McGill tube and the esophagoscope in the hypopharynx the grafted area was dilated to approximately its original diameter.

At the time of the patient's discharge, on May 28, five months after the operation, the diameter of the hypopharynx was approximately 2 cm. The tracheotomy wound was healed, and the patient had a normal speaking voice, without any signs of dyspnea or stridor.

SUMMARY

A case of stricture of the hypopharynx following ingestion of lye is presented in which a successful result was obtained by resection of the involved area, followed by application of a skin graft. This method provided a much more satisfactory and more rapid procedure than dilation for dealing with hypopharyngeal stricture.

RECURRING MASTOIDITIS, MENINGITIS AND ABSCESS OF RIGHT TEMPOROSPHEOID LOBE

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AND

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IN THIS era of antibiotics, brain abscess is apt to occur less frequently than before, but it does occur and must be coped with. A case of recurring mastoiditis, meningitis and abscess of the right temporosphenoid lobe is reported to remind ourselves of this fact and to point out our approach to adequate drainage of this abscess.

REPORT OF A CASE

E. H., a 12 year old boy, was admitted to the pediatric service of Dr. N. Einhorn, on Jan. 22, 1947, in a stuporous condition of eight hours' duration. Immediate consultation with Dr. A. S. Tornay, of the neurologic service, and one of us (B. H. S.) confirmed the diagnosis of brain abscess of the right temporosphenoid lobe secondary to chronic suppurative mastoiditis. The patient was directly transferred to our service for operation.

On his admission the following history was obtained from the parents. Since an attack of rheumatic fever six years previously complicated by acute suppurative otitis media, the patient had had occasional bouts of discharge from the right ear accompanying attacks of sinusitis, but these bouts had become more frequent. The most recent flareup occurred on Dec. 27, 1946. A severe earache, with purulent discharge, developed on the right side. The symptoms lasted until December 30 and then subsided. On January 10 the symptoms recurred, this time with a high temperature, severe frontal headache and pain in the joints. The headaches were described by the boy as being "like a hammer hitting my head." The pain radiated to the occiput and over the temporal bone of the right side.

The family physician prescribed sulfonamide drugs, codeine, acetylsalicylic acid and acetophenetidin U. S. P., which brought the temperature down, but the headache persisted. In the next few days the boy complained of light headedness and his appetite became poor. The symptoms again gradually diminished until one week later, when, on January 17, the headaches became worse than ever before, general weakness developed and the boy was confined to bed. On January 19 vomiting occurred, nonprojectile in character. This symptom continued on and off, and then, on January 22, the afternoon of admission, the parents noticed that the boy became stuporous and when shaken complained of severe headache. About one hour after the stupor had set in, it was noticed that the patient's arms extended and became rigid, with the hands adducted and the fingers flexed. There were no tremors or generalized convulsions. The parents then rushed the boy to the hospital.

A physical examination at this time disclosed a comatose condition, a temperature of 100.4 F., a pulse rate of 64, Macewen's sign and a blood pressure of 120 systolic and 80 diastolic. There was a slight purulent discharge from the right ear and tenderness over the mastoid, the left ear was normal. The right

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From the Ear, Nose and Throat Service of Dr. Benjamin H. Shuster, Philadelphia General Hospital

pupil was dilated and reacted slightly, the left pupil was contracted and reacted rapidly. There was palsy on the left side of the face of supranuclear type and weakness of the left arm and leg. The biceps and triceps reflexes were a trifle more active on the left side than on the right. A Babinski sign was elicited bilaterally. There was no definite nuchal rigidity. Approximately 2 D of choked disk was noted on the right side and less than 1 D on the left side. A lumbar puncture previously performed showed the spinal fluid pressure to be 360 mm of water. The fluid was clear. Microscopic examination revealed 90 cells, mostly polymorphonuclear, per cubic millimeter. A complete blood count showed 4,970,000 red cells, the high number probably being due to hemoconcentration, and 24,350 white cells, with 88 per cent polymorphonuclear cells and 12 per cent lymphocytes.

Because of these findings, a preoperative diagnosis of brain abscess of the right temporosphenoid lobe was made and an immediate mastoidectomy, with exposure of the middle and posterior fossae, was decided on. The patient was given 500 cc of 2.5 per cent dextrose in distilled water before operation to combat dehydration. Then, with the patient under general anesthesia, the usual post-auricular incision was made on the right side and a simple mastoidectomy was performed, careful attention being paid to cleaning out the cells around the lateral sinus plate. The plate was removed, and the sinus itself was exposed and palpated. There was no evidence of thrombus. The posterior fossa was exposed, with no evidence of pus. There was no definite fistulous tract through the tegmen tympani. Because of the localizing signs, it was felt that the abscess was situated fairly high in the substance of the temporosphenoid lobe. It was therefore decided to approach it through the squamous plate.

The mastoid incision was extended over the right auricle and the squamous plate exposed. With a rongeur forceps, part of the bone over von Bergmann's area was carefully bitten away and the dura of the middle fossa brought to view. It was under marked tension, thus accounting for the 2 D of papilledema. There were no pulsations, a fact which also seemed to point to a deep-seated abscess. A small incision was made in the dura over the temporosphenoid lobe but no pus escaped, therefore a cannula was inserted through the incision into the brain substance. The direction of insertion was almost perpendicular to the squamous plate, slightly upward and forward, for a distance of almost $1\frac{1}{2}$ inches (3.8 cm) from the dura. At this point it felt as if the cannula had pierced a thin, encapsulating membrane. About 30 cc of light green pus poured out under pressure. Subsequent culture of the pus proved it to be of *Streptococcus haemolyticus* origin. With the cannula as a guide, a small rubber tube was inserted into the abscess cavity and then anchored to the skin and subcutaneous tissue. About 5 cc of penicillin, 25,000 units to the cubic centimeter, was dropped into the abscess cavity through the rubber drain. The wound was packed lightly with iodoform gauze and left open, dry dressings and bandage were applied. The patient was placed under treatment with penicillin given parenterally and sulfonamide drugs administered by mouth, with instructions that the penicillin be dropped into the abscess cavity when it was being redressed.

After operation, the patient again received 500 cc of 2.5 per cent dextrose in water, by hypodermoclysis. He was given penicillin, 25,000 units every three hours, parenterally and sulfadiazine with sodium bicarbonate, 1 drachm (4 Gm) every four hours around the clock, by mouth. Dehydration was overcome by parenteral administration of fluids and appropriate electrolytes. Later during the day of operation, the patient's condition was only fair. His temperature and pulse and respiration rates were erratic, with little tendency to stabilize. His right pupil was not quite as dilated as before, but was still sluggish. There was a slight decrease in the papilledema, but the hemiparesis still persisted to the same degree.

The next day he began to show some improvement. His blood pressure, temperature and pulse and respiration rates began to show some evidence of stabilization. His blood count at this time showed slight anemia and a normal leukocyte count, accordingly, he was placed under treatment with liver extract, iron and vitamins.

When the wound was redressed, it was noted that quite a bit of purulent secretion was still coming from the drainage tube. The abscess cavity was irrigated by the gravity method with 100,000 units of penicillin in 10 cc of saline solution. This was continued daily until the eighth postoperative day, when the patient showed pronounced improvement. He was able to sit up in bed and was alert and responsive. During this time his temperature ranged from 99 to 100 F, but he felt so well that he clamored to get out of bed. He was allowed to sit up in a wheel chair and was able to be taken to the clinic for redressings.

On February 3, the eleventh postoperative day, he accidentally pulled the rubber drain out and had to be taken to the clinic the next day to have the tube replaced. The partially organized drainage channel was located, and another rubber tube was inserted into the abscess cavity, with the aid of a grooved director. Some



Position of drainage tube in abscess cavity

purulent discharge, about 2 cc, still exuded. Two days later, when the wound was again redressed, the tube was still in place and only a small amount of serous fluid was then draining from it. The patient was alert and felt well. To visualize the position of the drainage tube, a roentgenogram was taken, it showed that the tube apparently was still in the abscess cavity (figure).

On February 8, sixteen days after operation, the patient was seen in the eye clinic, and there was only slight evidence of papilledema and hyperphoria in the right eye. The pupils were practically normal. The patient was feeling very well. During the period in which he was coming to the clinic every other day for redressing of the wound, we gradually pulled out and shortened the rubber drainage tube about $\frac{1}{4}$ inch (0.6 cm) at a time.

On February 18, the twenty-sixth postoperative day, determinations of the visual fields revealed left homonymous hemianopsia, which suggested that some damage had been done by the brain abscess to the right optic radiation. This condition was still present when the patient was discharged. Except for this, he was doing well, so much so that, on February 24, the thirty-second postoperative day, the penicillin therapy was discontinued—use of sulfonamide drugs had been discontinued several days before. He continued to feel well and was free from symptoms until the thirty-sixth postoperative day, when he awoke with headache,

nausea and vomiting. His temperature was 100.2 F, the pulse rate 90 and the respiration rate 22. There was slight nuchal rigidity, the pupils were dilated, the right more than the left, with suggested Kernig and Brudzinski signs. There was a slight increase in the papilledema, and the disk margins were blurred, chiefly on the nasal side of the right eye. The patient was crying and moaning and was slightly delirious. A complete blood count taken at this time showed 4,610,000 red cells and 15,800 white cells, with 97 per cent polymorphonuclear cells and 7 per cent lymphocytes.

It was felt that this flare-up of meningeal irritation was probably due to the result of the drainage tube being shortened too soon and the discontinuance of the penicillin injections. This had caused a slight residual infection to light up. The small tube, therefore, was removed and a larger drainage tube inserted into the abscess cavity, about $2\frac{1}{2}$ inches (6.5 cm) from the edge of the wound. As the tube was being inserted, about 0.5 cc of purulent material exuded. The patient was then given about 100 cc of 50 per cent dextrose intravenously. Because of his restlessness and delirium he was given 1 drachm of chloral hydrate and $\frac{1}{2}$ grain (0.032 Gm) of phenobarbital. He was again placed under penicillin treatment, 50,000 units being given every three hours. A blood culture taken before the penicillin therapy was started showed a heavy growth of *Str. haemolyticus*. That night the temperature rose to 103 F, and there was an increase in nuchal rigidity with positive Kernig and Brudzinski signs. For two days the temperature ranged between 101 and 104 F and the pulse rate between 100 and 120; thereafter, the symptoms subsided gradually, and, finally, on March 3, the thirty-eighth post-operative day, the patient showed decided improvement. The temperature was down to 99 F, there was no nausea and he again became alert, responsive and cheerful. Two days later he was given a blood transfusion to bolster his resistance. From this time he improved daily. The discharge from the drainage tube, which first was purulent, gradually became serous, then, finally, there was no discharge at all.

On March 12, forty-eight days after operation, the patient was still feeling well. A complete blood count at this time showed 4,020,000 red cells and 8,100 white cells, with 60 per cent polymorphonuclear cells and 40 per cent lymphocytes. The rubber tube was again gradually pulled out and shortened, until, about the fifty-fifth postoperative day, it was entirely removed. This time no further flare-up occurred. Before discharge, another determination of the visual field showed left homonymous hemianopsia, of about the same degree as before. The blurring and papilledema of the disks were now completely gone. On March 21 the patient was discharged, completely free from symptoms except for the hemianopsia and slight weakness of the left side. When he was seen recently in the outpatient clinic he was completely free from symptoms and was gaining weight and feeling strong.

COMMENT

It was felt that dilatation of the pupil on the homolateral side and Macewen's sign (increased temperature with depressed pulse) were significant findings in helping to make a correct diagnosis.

Immediate exploration was an important factor in obtaining a successful result.

Minimum manipulation of the abscess cavity and the use of antibiotics were also important factors in arriving at a cure.

Even though some surgeons advocate complete excision of the abscess and other surgeons drain the brain abscess, instil penicillin and close the wound tightly, we believe that even with penicillin therapy it may still be a mistake to remove the drainage tube too early.

Progress in Otolaryngology

Summary of the Bibliographic Material Available in the Field of Otolaryngology

REVIEW OF ALLERGY FOR 1947

E L MacQUIDDY, M D

AND

E A HOLYOKE, M D

OMAHA

THE EFFECT of the return to peacetime work by many writers in the field of allergy is clearly shown in 1947 by the marked increase in the volume of literature on this subject and the consequent increased length of this review. The military aspects of allergy, so conspicuous for the last few years, are represented by only occasional papers. The various therapeutic measures recently developed, especially the antihistaminic compounds, have continued to be the most productive source of literature.

NOSE

King¹ reviews the problem of the patient with chronic nasal symptoms and emphasizes the importance of allergy in such a condition. He outlines a program of study of patients, including a careful history, physical examination and making of nasal smears. A history of an indefinite onset indicates the likelihood of allergy, and a general history, including asthma, urticaria, eczema or a family background of allergic conditions is strongly suggestive. The appearance of clouding of sinuses on roentgenograms may not be definite proof of infection. So-called hyperplastic ethmoiditis, King believes, is an early allergic manifestation. The presence of eosinophils in the nasal smear he regards as diagnostic of allergy. He does not consider cutaneous tests particularly reliable but feels that they should be tried, with a few of the common allergens. House dust and feathers should always be eliminated, and many patients are benefited simply by the covering of pillows and hyposensitization to house dust. King believes that allergy is becoming commoner. In his experience bacterial allergy is rare.

Putney² classifies sinusitis as allergic, mechanical and bacterial. The incidence of allergic sinusitis, either simple or complicated by infection,

1 King, E D. The Classification and Treatment of Patients with Chronic Nasal Symptoms, *Ann Otol, Rhin & Laryng* **56** 70-73, 1947

2 Putney, F J. Changing Concepts of Sinusitis, *Laryngoscope* **57** 664-670, 1947

is high Polypi originating from the ethmoid cells or around the antrum suggest allergy A constant discharge is a common complaint The nose may appear normal between attacks and be acutely inflamed during them Putney emphasizes the importance of conservative treatment The allergic diathesis, he feels, should be the chief object of attack through hyposensitization and the use of specific drugs Penicillin and the sulfonamide drugs are of no value in the absence of infection Davis³ also finds penicillin valueless in treatment of allergic conditions in the absence of infection Putney considers electrocoagulation or the use of sclerosing solutions of value in some cases but advises against surgical treatment if it can be avoided

Rawlins⁴ discusses the pathology of allergic sinusitis and reviews the antigen-antibody mechanism Locally, he describes intermittent increased capillary permeability and increased glandular activity with excessive mucous secretion The allergic membrane he regards as the chief cause of chronicity in sinusitis, and he feels that treatment should primarily be aimed at clearing it up The case history and the examination of nasal secretions for eosinophils are the chief points in diagnosis In another paper Rawlins⁵ discusses more fully a method for obtaining nasal secretions for examination Treatment, he believes, should be conservative so far as possible Perennial inhalants should be removed, and the patient should be hyposensitized to those that cannot be avoided The most important allergens, he feels, are house dust, molds, tobacco smoke and paper The methods for hyposensitization are discussed, and the importance of regulation of dose to the symptoms is emphasized

Lawson⁶ considers the nonseasonal type of allergic sinusitis of the most interest to the rhinologist Like King,¹ he does not find skin testing particularly effective and prefers tests with inhalants Desensitization treatment he has found highly successful He mentions three nonconservative measures, because "some patients will resist all conservative therapy" These measures are use of (1) the galvanic current, (2) the electrocoagulating current and (3) sclerosing solutions (5 per cent sodium morrhuate or 5 per cent solution of sodium psylliate [sylnasol®])

3 Davis, D Inhalation of Penicillin Aerosol and Penicillin-Streptomycin Aerosol in Office Practice, *Arch Otolaryng* **46** 307-317 (Sept) 1947

4 Rawlins, A G Chronic Allergic Sinusitis, *Laryngoscope* **57** 381-399, 1947

5 Rawlins, A G A Method of Obtaining Secretions from the Nasopharynx for Diagnosis of Nasal Allergy (Particularly Useful in Dry Noses), *Laryngoscope* **57** 95-96, 1947

6 Lawson, L J Changing Concepts of Therapy of Chronic Sinusitis, *Ann Otol, Rhin & Laryng* **56** 416-424, 1947

Robison⁷ again reviews his concept of the pathogenesis of allergic sinusitis and discusses his method of treatment by increasing tissue pressure through the use of a balloon filled with iodized oil introduced into the sinus. This pressure, he feels, helps to accelerate the absorption of stagnant tissue fluid.

In a discussion of nasal polypi, Shea⁸ states that most of these growths are allergic in origin. There are, however, a sufficient number of serious nasal growths to justify the microscopic study of all polypi removed. Allergic polypi, he feels, are usually pedunculated and generally occur in the middle meatus. The epithelium may vary from stratified squamous to columnar. The stroma is usually loose and infiltrated with exudate, with a few large and small mononuclear cells. Eosinophils are variable in occurrence and may be abundant during an attack and almost absent between attacks. Patients with hay fever may go for years without polypi, but patients with vasomotor rhinitis due to dust, fungi and food sensitivities are said constantly to possess them. Inflammatory polypi, in contrast to allergic polypi, are said to contain less exudate, to exhibit polymorphonuclear leukocytes and not to be limited to the middle meatus.

Hollender⁹ believes that after the surgical removal of polypi, zinc ion transfer is a valuable method in the prevention of recurrence. The allergic theory of causation of polypi he considers controversial.

Westcott¹⁰ outlines measures for treatment of patients with vasomotor rhinitis. He recommends a program of elimination of possible allergens and the use of high doses of vitamin A (50,000 to 100,000 units per day) in cases of bacterial allergy and of ascorbic acid (100 to 500 mg per day) in cases of allergy due to inhalant sensitivities. The antiallergic drugs are recommended for symptomatic relief.

McBean¹¹ has found nicotinic acid of value in the treatment of intrinsic vasomotor rhinitis. He also suggests a program of elimination of possible allergens, desensitization to house dust, electrocoagulation of mucous membranes over the turbinate bodies and the elimination of nose drops.

7 Robison, J. M. Pressure Treatment of Allergic Sinusitis, *Arch Otolaryng* **45** 405-431 (April) 1947.

8 Shea, J. J. The Pathology of Nasal Polyps and Related Growths, *Ann Otol, Rhin & Laryng* **56** 1029-1034, 1947.

9 Hollender, A. R. The Prevention of the Recurrence of Nasal Polyps. A Comparison of Results of the Postoperative Use of Radium and Zinc Ion Transfer, *Ann Otol, Rhin & Laryng* **56** 932-936, 1947.

10 Westcott, F. G. Perennial Vasomotor Rhinitis. A Modern Approach to Diagnosis and Treatment, *New York State J Med* **47** 57-59, 1947.

11 McBean, J. B. Observations on the Management of Vasomotor Rhinitis, *Minnesota Med* **30** 399-402, 1947.

Haas¹² presents a general review of allergy in rhinolaryngologic practice and outlines his method of handling allergic patients

HAY FEVER

In a discussion of the treatment of hay fever, Rackemann¹³ points out that a relatively small series of doses of pollen extracts can produce good clinical results if the quantities are correlated with the tolerance of the individual patient. If individual tolerance can be recognized, the danger of systemic reactions is not great, as dosage can be regulated below that level. Rackemann, however, emphasizes the variability of tolerance levels in different persons, and even in the same person during different seasons, so that great care and close study of good clinical records are necessary. He is of the opinion that the treatment of hay fever may be simplified in the future.

Lazarowitz¹⁴ found that the chilling method of injection (consisting of chilling the site of injection by bandaging on a small ice bag for fifteen minutes before and after injection) is of value in the safe treatment of extremely sensitive patients. No delayed reactions were observed in the treatment of 30 patients. The rationale of this method lies in slowing down the rate of absorption from the site of injection by vasoconstriction.

Zonis and Rubin¹⁵ report that they were unable to predict general reactions by testing patients with fractions of ragweed pollen. They feel that the fractions are not pure substances and that the impurities may be responsible for some reactions.

Egeberg and Painter¹⁶ report the results obtained with oral pollen therapy during the years 1937 to 1940. They conclude that it is a satisfactory method for the treatment of seasonal hay fever but that it has certain disadvantages as well as advantages. Against the method are the greater cost of material, the fact that it is a little less effective than parenteral treatment and that it requires careful supervision. In its favor is the absence of severe reactions and the fact that the needle is not required. Of 116 patients treated orally between 1938 and 1940, 60.6 per cent had good results, 22.8 per cent fair results, 6.3 per cent

12 Haas, L. R. Management of Allergy in Nose and Throat Practice, Eye, Ear, Nose Throat Monthly **26** 313-322, 1947

13 Rackemann, F. M. Pollen Tolerance, J. Allergy **18** 164-175, 1947

14 Lazarowitz, L. C. Effective Treatment of Extremely Sensitive Hay Fever Patients by the Chilling Method, J. Allergy **18** 104-108, 1947

15 Zonis, J., and Rubin, N. The Prediction of Constitutional Reactions by Testing with Ragweed Pollen Fractions, J. Allergy **18** 36-38, 1947

16 Egeberg, R. O., and Painter, J. M. Oral Pollen Therapy. A Comparative Study, Ann. Allergy **5** 415-419, 1947

questionable results and 10.2 per cent no results, whereas of 101 patients treated parenterally, 66.6 per cent had good results, 20.7 per cent fair results, 8.1 per cent questionable results and 4.5 per cent no results. Most patients treated were carried on 60,000 units given twice a week. During the first two years a maximum dose of 90,000 units was arbitrarily chosen, although as much as 240,000 units daily was given later. One patient had onset of asthma two hours after receiving 400 units and was carried on 200 units afterward. Three others acquired reactions to the administration of 15,000 units and their doses were reduced.

Urbach, Jaggard and Crisman¹⁷ obtained experimental evidence indicating the value of oral administration of pollen propeptans in hay fever. Pollen propeptans are derived from prolonged digestion of pollens with acids or acids and alkalis, depending on the pollen group. They are apparently devoid of native protein but retain the type-specific immunologic properties, which can be demonstrated by the passive transfer test. Properly controlled oral, intravenous or bronchial administration of pollen propeptans was found to protect highly sensitized guinea pigs against as high as 20 minimum lethal doses of appropriate allergens.

On the basis of several years' intensive study of 14 patients with hay fever and bronchial asthma, Brown, Holden and Nobili¹⁸ have found an unexpected blocking antibody response to oral pollen therapy. The level did not seem to be related to the patient's clinical progress. Cutaneous tests and ophthalmic tests did not necessarily correspond to improvement or lack of improvement. No long range variations of importance were found during the four year follow-up study.

Hansel¹⁹ reports good results in obtaining relief of hay fever and asthma with nethaphyl® (a combination of nethamine [methylethylamino-phenylpropanol] hydrochloride and butaphyllamine theophylline aminoisobutanol).

Hebald, Cooke and Downing²⁰ found histamine azoprotein of little value in the treatment of patients with hay fever.

17 Urbach, E., Jaggard, G., and Crisman, D. W. The Chemical and Immunologic Basis of Oral Pollen Propeptan Therapy in Hay Fever, *Ann Allergy* 5 147-155, 1947.

18 Brown, E. A., Holden, E. M., and Nobili, C. The Skin-Test Blocking Antibody Response to Oral Pollen Therapy and Criteria for Its Use, *Ann Allergy* 5 402-414, 1947.

19 Hansel, F. K. Nethaphyl in the Treatment of Nasal Allergy and Bronchial Asthma, *Ann Allergy* 5 397-401, 1947.

20 Hebald, S., Cooke, R. A., and Downing, L. M. Clinical and Serologic Study of Ragweed Hay Fever Patients Treated with Histamine Azoprotein (Hepamine), *J Allergy* 18 13-15, 1947.

HEADACHE

Hersh²¹ gives an excellent review of the etiology of headache, in which he covers a considerable volume of literature on the subject. In a study of 1,000 cases, he found vasomotor rhinitis to be the commonest etiologic factor. Other factors listed include myositis cervicalis, mechanical obstruction of the nose, sinusitis, neuropsychotic disorders, vascular cephalalgia, ophthalmic, pharyngeal and dental disturbances, involvements of the cervical portion of the spine, otic disturbances, atrophic rhinitis and anemia. Vasomotor rhinitis was the chief factor in 282 cases, an accessory factor in 130 and one of multiple factors in 140 cases. In 231 of the cases of vasomotor rhinitis the condition was considered to be on an allergic basis. Of the cases of vascular cephalalgia, the pain was considered as histamine headache in 5 cases, as migraine in 13 cases, as due to hypertension in 3 cases and as due to an aneurysm in 1 case. Only those vascular headaches preceded by an aura, lasting twelve hours or more and relieved by ergotamine tartrate (gynergen®) were considered as migraine. Histamine desensitization proved to be very successful in the group of histamine headaches. Hersh feels that physical allergy may be an important factor in myositis cervicalis.

Shuey²² does not believe that many vascular headaches are allergic in origin. Over one half of those not on an organic basis, he feels, are due to psychogenic factors. In only 1 of a group of 16 cases was the headache thought to be allergic.

Hansel²³ and Macy and Horton²⁴ discuss the use of histamine in the treatment of some forms of headache. Hansel states that in 32 of 126 cases of unilateral headache the condition was due to histamine. These cases could be differentiated from cases of migraine on the basis of short attacks and the absence of visual disturbances, and from cases of trigeminal neuralgia by the absence of a trigger zone. Sweating, tearing, nasal congestion and flushing of the skin on the involved side he found rather characteristic. The headache in these cases was usually controlled with graduated doses of histamine. Five cases are reviewed in detail.

21 Hersh, J. H. Some Present Day Concepts of Headache, *Ann Otol, Rhin & Laryng* **56** 98-119, 1947.

22 Shuey, C. B. Vascular Mechanisms in Allergic Headaches, *South M J* **40** 440-443, 1947.

23 Hansel, F. K. The Treatment of Certain Types of Headache with Histamine, *Ann Otol, Rhin & Laryng* **56** 152-160, 1947.

24 Macy, D., and Horton, B. T. The Treatment of Migraine with Histamine. Review of One Hundred and Forty-Four Cases, *J Lab & Clin Med* **32** 1546, 1947.

Macy and Horton²⁴ review a series of 144 cases of migraine. After statistical analysis of their results, they found that the headache of from 23 to 33 per cent of patients was unchanged by histamine therapy. Significant improvement occurred in 33 to 50 per cent of patients with typical migraine and in 40 to 66 per cent of patients with atypical migraine on the intravenous injection of histamine. In 60 per cent of patients with typical migraine there was improvement when histamine was given subcutaneously. Histamine given by both routes was followed by improvement in 70 to 85 per cent of patients with typical migraine and in 74 to 100 per cent of patients with atypical migraine. In 85 per cent there were recurrences, unless the histamine was given up to a critical dose. Macy and Horton conclude that histamine is not specific in the treatment of migraine.

Holden²⁵ feels that food sensitivity is the factor chiefly responsible for migraine. He discusses the disease and its treatment from the point of view of the ophthalmologist.

Alvarez²⁶ believes that migraine is primarily a hereditary disease of the brain and that nothing is to be gained by looking for demonstrable pathologic factors in its cause. He is of the opinion that it may be mild, or even latent, in some cases and that it becomes disabling when complicated by hereditary allergy, hypertension, psychopathy or constitutional inadequacy.

The Singhs²⁷ report on the use of progesterone in the treatment of 23 patients with migraine. These patients all showed evidence of estrogenic overactivity, and in all of them symptoms were prevented or relieved.

MENIERE'S SYNDROME

Lyman²⁸ calls attention to what he feels is a chaotic state in the literature on Ménière's disease. He shows the extent to which the term has become loosely used, and hence indefinite in meaning, and suggests that it be dropped in favor of the term "hydrops of the labyrinth," which is descriptive of the true condition.

Cawthorn²⁹ discusses the pathology and history of Ménière's disease and points out that some authors consider it a disturbance in water

25 Holden, F. A. Migraine as Seen by the Ophthalmologist, *South M J* **40** 757-760, 1947.

26 Alvarez, W. C. The Migrainous Personality and Constitution. The Essential Features of the Disease, A Study of Five Hundred Cases, *Am J M Sc* **218** 1-8, 1947.

27 Singh, I., Singh, I., and Singh, D. Progesterone in the Treatment of Migraine, *Lancet* **1** 745-747, 1947.

28 Lyman, H. W. Meniere's—A Synonym of Confusion, *Ann Otol, Rhin & Laryng* **56** 352-356, 1947.

29 Cawthorn, T. Meniere's Disease, *Ann Otol, Rhin & Laryng* **56** 18-38, 1947.

balance and others an allergic phenomenon. He has encountered few instances in which sepsis was a probable cause and does not believe that the syndrome is due to pressure on the eighth nerve. He reviews 424 cases (234 of males, 190 of females) and finds that the largest group of patients was between the ages of 40 to 50. Treatment is discussed and the importance of reassurance to the patient emphasized. Phenobarbital and scopolamine are said to help some patients, and limitation of fluids and use of a salt-free diet are said to be the best conservative measures. Histamine injections may be of benefit in some cases. Focal infection probably should be searched for, although Cawthorn does not believe that it is a likely cause. Cawthorn also feels that too much attention is given by some authors to insufficiency of the eustachian tube. Surgical treatment is discussed, and references to the literature are cited.

Williams³⁰ gives an excellent review of Ménière's disease, with extensive citing of the literature on the history, pathology, etiology, diagnosis and treatment, both medical and surgical. He is of the opinion that there is evidence for considering Ménière's disease a form of physical allergy and relating it to myalgia. There is also evidence indicating the antigen-antibody type of allergy. Histamine tests seemed to be of no value in forecasting the results of histamine treatment. Williams' findings do not support Atkinson's³¹ belief that there are both vasodilator and vasospastic types, since the response of all types was equally good to administration of both histamine and nicotinic acid. The differential diagnosis of Ménière's disease is discussed.

Atkinson³¹ again states his theory of vasospastic and vasodilator types of Ménière's disease. Of 22 cases of the vasodilator type, he obtained relief with histamine in 1. There was improvement in 10 cases and no change in 11.

Harris³² reports on a series of 112 patients with Ménière's disease treated with intravenous injection of histamine. In 71 patients the tinnitus was completely relieved, in 24 it was described as markedly improved and in 13 as considerably improved. Four patients had no relief. Hearing was improved in 89 per cent of the patients, and vertigo was relieved in 87 per cent.

30 Williams, H. L. The Present Status of the Diagnosis and Treatment of Endolymphatic Hydrops (Meniere's Disease), *Ann Otol, Rhin & Laryng* 56 614-646, 1947

31 Atkinson, M. Tinnitus Aurium. Some Considerations Concerning Its Origin and Treatment, *Arch Otolaryng* 45 68-76 (Jan) 1947

32 Harris, R. The Intravenous Administration of Histamine as a Treatment of Meniere's Syndrome, *South M J* 40 761-767, 1947

Of 340 cases reviewed by Kajaer,³³ signs of allergy were present in only 25 per cent, and in none was there evidence of labyrinthine anaphylaxis. Kajaer therefore feels that the allergic processes may affect the vestibular apparatus secondarily through mucosal alteration of the nose and eustachian tube, in contrast to Cawthorn's opinion, previously cited. In many of these cases the condition might thus be considered as pseudo Meniere's disease rather than as true endolymphatic hydrops.

McMahon,³⁴ on the other hand, believes that the allergic etiology of Meniere's disease should always be considered. He favors the usual allergic management of seeking for the offending allergens, followed by avoidance, desensitization and the use of specific drugs.

Lewy and Fox,³⁵ treated 47 patients with Meniere's disease with pyridoxine (vitamin B₆). Fifteen of these patients had been under the Furstenberg treatment, and these responded well. Three patients represented complete therapeutic failures, while several others responded very slowly, so that spontaneous recovery may have been possible.

EYE

In a review of the allergic manifestations of the eye, Speas³⁶ includes the conditions of angioneurotic edema, blepharitis, conjunctivitis and keratitis. After drug therapy, iritis, cyclitis, uveitis, endophthalmitis or retinitis may develop. A long list of drugs which may be allergens is given; it includes acetylsalicylic acid, atropine, mercury, barbiturates, camphor, quinine, coal tar products, dinitrophenol, sulfathiazole, local anesthetics and physostigmine. Speas feels that in some cases scintillating scotoma, cataract and sympathetic ophthalmia may also be on an allergic basis. Diagnosis, in his opinion, is to be made on the basis of the history, tests for sensitivity (both cutaneous and conjunctival), elimination and inspection of environment. Vernal conjunctivitis, particularly the limbic type, is said to be the commonest ocular manifestation of allergy. Speas recommends the usual allergic regimen, supplemented by such measures as addition of calcium, histamine therapy, salt-free diet, irrigation of the eyes and use of vasoconstricting drugs in the treatment of this condition.

33 Kajaer, M. Meniere's Disease and Allergy, *Acta oto-laryng* **35** 390-403, 1947.

34 McMahon, B. J. Influence of Constitutional Factors in Otological Conditions, *Ann Otol, Rhin & Laryng* **56** 298-304, 1947.

35 Lewy, A., and Fox, N. Pyridoxine (B₆) used in the Treatment of Vertigo, *Arch Otolaryng* **46** 681-683 (Nov.) 1947.

36 Speas, W. P. Some Allergic Manifestations of the Eye, *North Carolina M J* **8** 364-366, 1947.

Woods³⁷ discusses the allergic aspects of endogenous uveal disease. He is particularly concerned with the ordinary nonpurulent uveitis, iritis or choroiditis, although he recognizes the allergic element in sympathetic ophthalmia and endophthalmitis phacoanaphylactica. Two types of uveitis, nongranulomatous and granulomatous, are differentiated. In the former the bacterial invasion is a minor factor, producing principally local hypersensitivity, which in turn is responsible for allergic manifestations to bacterial products. In the latter the organisms themselves produce lesions, with consequent inflammation, caseation, tissue destruction and often a compensatory overgrowth of granulomatous tissue, features lacking in the nongranulomatous type. The type which develops is dependent on the immunity of the patient and the numbers and virulence of invading organisms. Tuberculosis is used to illustrate the foregoing statements, and Woods feels that, with minor variations, the illustration would hold for other types of organisms as well. A general definition of allergies and their types and a discussion of related immunologic phenomena are given at the beginning of the paper.

Berens, Girard and Cummings³⁸ present 3 cases of simple glaucoma in which allergic reactions to foods were demonstrated by the pulse-diet method of Coca. In 1 case the disease was brought under control only after institution of an allergen-free diet. In the other 2 cases medical and surgical treatment resulted in control of the glaucomatous hypertension. The progressive loss of visual fields, however, was not checked until allergens were eliminated from the diet, after which there was notable improvement.

A case of glaucoma in a young woman following the oral administration of sulfathiazole is reported by Fritz and Kesert.³⁹

Hogan⁴⁰ describes a thin, transient membrane which may form on the conjunctiva of the tarsus during the early acute phase of vernal conjunctivitis, its presence suggests an allergic basis in some cases of membranous conjunctivitis.

Six cases of keratitis rosacea due to proved sensitivity to testosterone, with improvement under desensitization treatment, are reported by Zondek, Landau and Bromberg.⁴¹

37 Woods, A. C. The Influence of Hypersensitivity on Endogenous Uveal Disease, *Am J Ophth* **30** 257-274, 1947.

38 Berens, C., Girard, L. J., and Cummings, E. Allergy in Glaucoma, *Ann Allergy* **5** 526-535, 1947.

39 Fritz, M. H., and Kesert, M. Glaucoma Following the Ingestion of Sulfathiazole, *Am J Ophth* **30** 197-198, 1947.

40 Hogan, M. J. Conjunctivitis with Membrane Formation, *Am J Ophth* **30** 1495-1513, 1947.

41 Zondek, B., Landau, J., and Bromberg, Y. M. Allergy to Endogenous Hormones as a Cause of Keratitis Rosacea, *Brit J Ophth* **31** 145-155, 1947.

Harbert and McPherson⁴² and Goldsmith⁴³ discuss the possible role of sulfonamide compounds in treatment of periarteritis nodosa. Harbert and McPherson point out that the number of cases has greatly increased since the advent of the widespread use of these drugs, they feel that the compounds may act as haptens, combining with the plasma proteins to form allergens. They report a case of scleral necrosis occurring during the course of periarteritis nodosa. Goldsmith⁴³ reports a case with autopsy in which the diagnosis is said to have been made on the basis of ophthalmoscopic changes in conjunction with physical findings and the clinical course. The choroidal and retinal arteries were involved.

Sack⁴⁴ reports a case of bilateral cataract developing suddenly in a girl of 17 after neurodermatitis, of fifteen years' duration. About 30 similar cases are said to have been reported previously in both American and European literature. Both the neurodermatitis and the cataracts were thought to have an allergic basis, although the mechanism of production of the cataract is not known. The prognosis of the cataract is said to be good under proper surgical management.

Ruiz-Moreno⁴⁵ describes a monilid of the eyelid which is thought to be a tuberculin type of reaction to *Candida albicans*. There is a dry, scaly, severely itching dermatitis bilaterally on both upper and lower eyelids. It often occurs seasonally. Some degree of success has attended treatment with an aqueous extract of *C. albicans*.

Yasuna,⁴⁶ discussing penicillin therapy in uveitis, cites 2 cases in which recovery was hindered rather than aided by it. In his opinion, bacterial products from foci of infection in other areas released on penicillin therapy were responsible for the aggravation of symptoms.

The results of penicillin therapy in 55 cases of infections of the conjunctiva and eyelid are reported by Noe,⁴⁷ who found allergic dermatitis in 16 per cent. Results, although striking in a few cases, were not, on the whole, superior to those obtained with other forms of therapy.

42 Harbert, F, and McPherson, S. D. Scleral Necrosis in Periarteritis Nodosa, *Am J Ophth* **30** 727-732, 1947

43 Goldsmith, J. Periarteritis Nodosa with Involvement of the Choroidal and Retinal Arteries, *Am J Ophth* **29** 435-446, 1947

44 Sack, S. S. Atopic Cataract. Report of a Case with Tabulated Summary of Previously Reported Cases, *Ann Allergy* **5** 353-363, 1947

45 Ruiz-Moreno, G. Eczematoid Monilid of the Eyelids ("Candidid"), *Ann Allergy* **5** 132-136, 1947

46 Yasuna, E. R. Danger of Penicillin Therapy in Active Uveitis, *Arch Ophth* **37** 598-607 (May) 1947

47 Noe, C. A. Penicillin Treatment of Eyelid Infections, *Am J Ophth* **30** 466-479, 1947

Iliff⁴⁸ has had excellent results with beta irradiation in the treatment of vernal conjunctivitis. Of 60 patients so treated, 30 per cent (18) were cured and the condition of 63 per cent (38) was improved. In 7 per cent (4 patients) there was no improvement.

ASTHMA

Lowell and Schiller,⁴⁹ studied the vital capacity of asthmatic persons, and found a reduction to as little as 60 per cent after inhalation of aerosolized extracts of pollens of birch, oak, grasses and ragweeds. The subjects with the severest asthma suffered the greatest reduction. In all but 1 subject the vital capacity returned to its previous level in fifteen minutes.

Finke⁵⁰ analyzes a series of 100 cases of a condition he considers to be infectious bronchial asthma and states the opinion that it is basically chronic bronchitis. In these cases the asthma is regarded as a symptom, to be considered apart from allergic bronchial asthma, and allergic findings are coincidental. Rational therapy in such cases should be directed toward the infection and should include the administration of sulfonamide compounds and antibiotics. Finke states that such measures may avoid serious pulmonary disease, such as bronchiectasis.

Scherago⁵¹ considers bacterial allergy important in the etiology of asthma. He emphasizes the following factors which may exist in the relation of bacterial infection to atopic allergy: 1. Body resistance to entrance of foreign substances is lowered in an infection. 2. Infection may lower the threshold in sensitive persons and so cause them to show symptoms. 3. Allergic symptoms may disappear in severe febrile reactions. 4. Original simple allergy may be complicated by infection.

Plotz⁵² discusses cardiac asthma and concludes that bronchospasm is an important element in certain types of heart disease and that there are cases in which cardiac asthma is indistinguishable from allergic bronchial asthma. In such cases with no basal rates, the use of epinephrine leads to a sharp increase of vital capacity. In cases with basal rates the drug does not have this effect.

⁴⁸ Iliff, C. E. Beta Irradiation in Ophthalmology, *Arch. Ophth.* **38** 415-441 (Oct.) 1947.

⁴⁹ Lowell, F. C., and Schiller, I. W. Reduction in the Vital Capacity of Asthmatic Subjects Following Exposure to Aerosolized Pollen Dusts, *Science* **105** 317, 1947.

⁵⁰ Finke, W. The Significance of Chronic Bronchitis in Infectious Bronchial Asthma, *Ann. Allergy* **5** 364-375, 1947.

⁵¹ Scherago, M. Bacterial Allergy, *Ann. Allergy* **5** 1-18, 1947.

⁵² Plotz, M. Bronchial Spasm in Cardiac Asthma, *Ann. Int. Med.* **26** 521-525, 1947.

Seven cases of death of asthmatic persons, thought to be due to cardiac complications, are presented by Lowance and co-workers⁵³ Acute dilatation of the right side of the heart and severe emphysema were observed in 1 of these cases at autopsy

Rowe and Rowe⁵⁴ studied a group of 173 private patients with bronchial asthma who were over 55 years of age They believe that food and inhalant allergies are the most frequent causes of bronchial asthma in this age group and that they occur with about equal frequency Rowe and Rowe believe that there is minimal evidence of bacterial allergy as a factor in infectious asthma and did not consider it a major cause in any case in this series

The absolute contraindication of morphine in the treatment of bronchial asthma is emphasized by Peterson,⁵⁵ who presents a physiologically *rational outline of treatment for status asthmaticus* Treatment includes full use of helium-oxygen mixtures with heavy ether in oil given rectally or with ether inhalation anesthesia as required by the state of excitement of the patient Bronchoscopy with the removal of mucous plugs is recommended A fatal case of asthma, complicated by mediastinal and subcutaneous emphysema, is described, and similar cases are cited from the literature

Ratner,⁵⁶ writing on pediatric allergy, points out that asthma rarely begins before the ages of 3 to 8 years Frequent bouts of rhinitis usually precede the asthma Food sensitivity is not considered as important as inhalant sensitivity

Chobot,⁵⁷ however, states that food sensitivity and bacterial infections are the chief causes of asthma during the first few years of life He feels that food sensitivity tends to disappear later and that there is a free period until the inhalant sensitivities begin to take on a major role The importance of bacterial infection is emphasized, and the removal of tonsils and adenoids and the use of autogenous vaccines are urged In another paper, Chobot⁵⁸ discusses the differential diagnoses of asthma

53 Lowance, M I, Jones, E C, Mathews, W B, and Dunston, E M Cardiac Complications and Deaths in Asthmatic Patients, *South M J* **40** 508-514, 1947

54 Rowe, A H, and Rowe, A, Jr Bronchial Asthma in Patients over the Age of Fifty-Five Years Diagnosis and Treatment, *Ann Allergy* **5** 509-518, 1947

55 Peterson, H A Fatal Case of Bronchial Asthma Complicated by Mediastinal and Subcutaneous Emphysema, *J Allergy* **18** 413-416, 1947

56 Ratner, B Pediatric Approach to Management of Asthma in Childhood, *New York State J Med* **47** 861-865, 1947

57 Chobot, R Pediatric Allergy, *West Virginia M J* **43** 159-162, 1947

58 Chobot, R Differential Diagnosis and Symptomatic Treatment in Asthmatic Patients, *Am Pract* **1** 436-438, 1947

The problem of asthma in military personnel is discussed by Smith⁵⁹ and Fishman⁶⁰. Smith states that bronchial asthma cannot be successfully treated in a military environment, as there are too many factors beyond the control of the physician. A hundred cases are presented in which the men were disabled an average of 114.5 days each. Of these, 78 per cent had a preenlistment history of asthma.

Fishman⁶⁰ also reviews the cases of 100 patients with asthma evacuated from overseas. Of these, 56 had no previous history of asthma, and 78 were asymptomatic and needed no further treatment on return to the United States.

Waldbott⁶¹ questions whether or not sufficient emphasis is placed on the rehabilitation of the asthmatic patient after an attack. The customary methods of treatment are, of course, necessary during the attack, but Waldbott feels that harm can be done by unduly extending such measures. He outlines a program to overcome the invalidism of the asthmatic patient which includes carefully graded light exercises, gradual exposure to such antigens as animal emanations and house dust, and the institution of a high caloric diet if the patient is emaciated. Duke's method of gradually building up tolerance against sudden changes in temperature is suggested, and the elimination of habitual medication, especially by use of hypodermics and atomizers, is advised.

In cases of advanced allergic emphysema, Kahn⁶² points out that treatment must be directed against the emphysema, as well as the asthma. Many of the patients are extremely sensitive, and care is necessary in injection treatment. The results of cutaneous tests are frequently negative, but good results may still be obtained from hypsensitization. Kahn feels that allergic rhinitis, sinusitis and polyposis are frequently associated and that, while polypi should be removed, a meticulous allergic regimen is the most important measure. Rest is considered an important part of therapy. Complete recovery when emphysema is well established cannot be expected.

Grove⁶³ urges surgical treatment for sinusitis in asthmatic patients and reports 200 cases in which operation was performed. He advises the use of antiallergic measures after operation.

⁵⁹ Smith, D. S. Chronic Asthma. Results of Treatment in One Hundred Cases, *U. S. Nav. M. Bull.* **47** 302-306, 1947.

⁶⁰ Fishman, A. P. Etiologic Evaluation of Asthma in One Hundred Cases Returned from Overseas, *J. Allergy* **18** 115-124, 1947.

⁶¹ Waldbott, G. L. Does the Routine Treatment of Asthma Need Revision? *Ann. Allergy* **5** 126-131, 1947.

⁶² Kahn, I. S. Advanced Allergic Emphysema, *South. M. J.* **40** 62-66, 1947.

⁶³ Grove, R. C. Sinusitis and Allergic Diseases, *Ann. Pract.* **1** 468-474, 1947.

The use of radium in the treatment of asthmatic children is discussed by Ward, Livingston and Moffat,⁶⁴ who report 34 cases. The application of 2 gram minutes to each side of the nasopharynx monthly for an average of four treatments resulted in complete disappearance of lymphatic tissue in 23 of the 34 cases, in 15 of which the asthma was completely relieved. In 5 others mild attacks continued, and in 3 the asthma was reported as improved.

Crowe and Walzl⁶⁵ found that asthma was improved during radiation treatment for deafness.

Barach and Garthwaite⁶⁶ report on the effectiveness of physiologic and antibiotic therapy in cases of intractable bronchial asthma. In patients becoming refractory to epinephrine and aminophylline, they found that substitution of meperidine hydrochloride (demerol hydrochloride[®]), in 50 cc doses to avoid side effects, and inhalation of 50 per cent oxygen will often terminate persistent bronchial spasm. Intravenous injection of isotonic or hypertonic dextrose solution is often helpful. Physiologic therapy also includes helium-oxygen inhalation, positive pressure respiration, ether anesthesia, bronchoscopy and induction of artificial fever. Antibiotic therapy is said to have limited, but unquestionable, value in selected cases.

Miller,⁶⁷ also writing on the physiologic basis of treatment of intractable asthma, points out that such therapy depends on the realization that bronchial asthma always means obstruction, whether due to bronchial spasm, mucus plugging or bronchial edema, that the asthma is a defense mechanism and that the usual causes are infection and allergy.

Goodall and Unger⁶⁸ treated 10 patients in status asthmaticus by the continuous intravenous administration of aminophylline and recommend this treatment in the severest types of cases. Two to 3 Gm of aminophylline dissolved in 2,000 cc of 5 per cent dextrose in distilled water or isotonic sodium chloride solution was given at the rate of 28 drops per minute. Goodall and Unger feel that large doses should be used initially and should be gradually reduced as the asthmatic symp-

64 Ward, A. T., Jr., Livingston, S., and Moffat, D. A. Asthma in Children. Treatment with the Radium Nasopharyngeal Applicator, *J. A. M. A.* **133** 1060-1062 (April 12) 1947.

65 Crowe, S. J., and Walzl, E. M. Irradiation of Hyperplastic Lymphoid Tissue in Nasopharynx, *J. A. M. A.* **134** 124-127 (May 10) 1947.

66 Barach, A. L., and Garthwaite, B. Physiologic and Antibiotic Therapy of Intractable Bronchial Asthma, *Ann. Allergy* **5** 297-316, 1947.

67 Miller, H. Physiological Basis of the Treatment of Intractable Asthma, *California Med.* **66** 128-130, 1947.

68 Goodall, R. J., and Unger, L. Continuous Intravenous Aminophyllin Therapy in Status Asthmaticus, *Ann. Allergy* **5** 196-202, 1947.

toms subside Complete or partial relief was obtained in 9 of the 10 cases, but the authors state that relapse may occur when the treatment is discontinued

Prigal, Brooks and Harris⁶⁹ administered aminophylline to asthmatic patients in the form of an aerosol from a new combination steam generator and aerosolizer, which they state is inexpensive and practical The dose of aminophylline required when given in this way is extremely low (it is estimated that not more than 0.05 Gm is inhaled) as compared with what is required for the effective intravenous treatment Side effects are thereby avoided The apparatus can also be used for penicillin therapy when indicated Of 40 patients with asthma treated with aerosol of aminophylline, 32 obtained some relief Five patients with severe asthma who failed to respond to intravenous administration of aminophylline were relieved It is stated, however, that some patients will respond to intravenous use of aminophylline who do not respond to the aerosol, and in some the condition is refractory to both treatments The vital capacity was increased to an average of 20.6 per cent in 9 cases in which studies were made

Wyrens⁷⁰ also reports on the use of aminophylline in the treatment of asthma He considers an average dose $7\frac{1}{2}$ grains (450 mg) of aminophylline in 10 cc of solution given parenterally and recommends suppositories containing $7\frac{1}{2}$ grains for home administration He emphasizes the value of aminophylline in cases in which epinephrine is contraindicated

Segal and Beakey⁷¹ report on the use of a new bronchodilator drug, isuprel[®] hydrochloride (1-[3,4'-dihydroxyphenyl]-2-isopropylamino-ethanol hydrochloride) in the treatment of bronchial asthma They have used the drug in subcutaneous doses of 0.2 to 0.33 cc of 1:1,000 solution and in oral doses of 30 to 60 mg daily, as well as in the form of an aerosol with oxygen in doses of 1 cc of a 1:100 dilution every three hours They have found alarming reactions from subcutaneous doses of more than 0.5 cc of a 1:1,000 solution and state that isuprel[®] should not be given intravenously Small doses can be given until individual tolerance is determined Pressor effects and tachycardia are said to be minimal The results in 82 ambulatory patients treated by oxygen aerosolization of isuprel[®] and 40 hospital patients treated by one or more methods are presented Eighty-five per cent of severely ill hos-

69 Prigal, S. J., Brooks, A. M., and Harris, R. The Treatment of Asthma by Inhalation of Aerosol of Aminophyllin, *J. Allergy* **18** 16-28, 1947

70 Wyrens, R. J. Aminophyllin in the Treatment of Asthma, *Nebraska M. J.* **32** 273-274, 1947

71 Segal, M. S., and Beakey, J. F. Management of Bronchial Asthma The Use of 1-3',4'-Dihydroxyphenyl-2-Isopropylaminoethanol, *Ann. Allergy* **5** 317-336, 1947

pital patients were kept comfortable with this drug alone. The vital capacity was improved as subjective relief was obtained, and the fluctuations in blood pressure on inspiration and expiration were abolished or greatly reduced. Eleven epinephrine-fast patients responded favorably, and no fastness to isuprel® was observed.

Barach and Garthwaite⁶⁶ discuss the use of penicillin for patients with severe bronchial asthma. Of 60 patients who received 91 courses of penicillin treatment, clinical improvement is said to have been pronounced in 16 and moderate in 19. In 36 patients improvement was slight, and in 20 there was none. Of 35 patients who were greatly or moderately benefited, 21 continued to show improvement longer and 14 less than two months. Improvement is more sustained in cases in which hyposensitization therapy with catarrhal vaccine and dust is instituted after penicillin treatment and continued indefinitely. Barach and Garthwaite state that penicillin has limited, but unquestionable, value in selected cases of asthma.

* The results in 29 cases of asthma treated by intravenous administration of penicillin are reported by Miller,⁷² who concludes that the drug is valuable in combating infectious processes, and is thus effective in a significant group of cases of bacterial asthma. It is not, however, a panacea in the treatment of intrinsic asthma. He is of the opinion that the results are not conclusive at present, but warrant further study of the use of penicillin in treating bacterial asthma.

Prigal, Morganbesser and McIntyre⁷³ discuss the use of steam-generated aerosols of penicillin in the treatment of infections associated with allergies, such as infectious asthma, bronchiectasis, bronchitis and sinusitis. They attach considerable importance to their method as a prophylactic measure and point out that the relief obtained may be temporary. In cases of status asthmaticus it is recommended that preliminary treatment with aerosols of aminophylline and ammonium chloride be administered (Prigal and associates⁶⁹). Various methods for conserving and administering the aerosol are described.

Segal and Ryder⁷⁴ report on 85 patients with pneumonia, infective bronchitis, infective bronchial asthma, pulmonary abscess, bronchiectasis, infective laryngotracheobronchial edema, pulmonary emphysema and pulmonary blebs who were treated with penicillin aerosol. There was

72 Miller, M. W. Penicillin in Intractable Asthma, *J. Allergy* **18** 109-114, 1947.

73 Prigal, S. J., Morganbesser, L. J., and McIntyre, F. P. Penicillin Aerosol in the Prevention and Treatment of Respiratory Infections in Allergic Patients, *J. Allergy* **18** 325-336, 1947.

74 Segal, M. S., and Ryder, C. M. Penicillin Inhalation Therapy, *New England J. Med.* **236** 132-138, 1947.

considerable improvement in many of these cases. The authors caution against indiscriminate use of the method.

The use of penicillin in oil and wax in the treatment of 39 patients with intrinsic asthma is discussed by Gay and Marriott⁷⁵. They injected 600,000 units of penicillin, followed by similar booster doses every five to seven days, and obtained improvement in 31 patients. Gay and Marriott conclude that the method should be tried in any case of infective asthma and that a majority of patients will be benefited by it.

Some of the dangers attending methods of treatment in asthma are pointed out by Mertins⁷⁶ and Polonio⁷⁷. Mertins reports several cases of extreme self medication with naphazoline hydrochloride (privine hydrochloride®) with addiction and collapse on withdrawal, while Polonio presents a series of cases of addiction to meperidine (demerol®).

Rackemann,⁷⁸ in a discussion of the causes of asthma, emphasizes the general principle that the treatment of an asthmatic patient as a whole man is more important than the treatment of his asthma.

ETIOLOGY OF ALLERGIES

In a statistical study of intense palmar sweating, as determined by the Silverman technic, Cohen and Wolf⁷⁹ report that there is a significant increase in atopic persons. This increase, they maintain, is a manifestation of the allergic state and is not due to sampling errors, as race, sex and age are without influence on the results. They conclude that respiratory allergies are probably dependent on an inherent behavior pattern of the autonomic nervous system, as well as on hypersensitivity on an immunologic basis.

Swanton⁸⁰ is also of the opinion that asthma may represent an inherited stigma of the autonomic nervous system.

Jimenez Diaz, Lahoz and Canto⁸¹ enumerate the factors in mill dust which they feel might cause occupational asthma in such groups as farmers and millers. They include rust and smut, as well as Coleoptera

75 Gay, L. N., and Marriott, H. J. L. The Treatment of Infective Asthma with Penicillin in Beeswax and Oil, *Tr. & Stud. Coll. Physicians, Philadelphia* **15** 91-103, 1947.

76 Mertins, P. S., Jr. Excessive Self Medication with Naphazoline Hydrochloride ("Privine Hydrochloride"), *J. A. M. A.* **134** 1175 (Aug. 2) 1947.

77 Polonio, P. Pethidine Addiction, *Lancet* **1** 592-594, 1947.

78 Rackemann, F. M. New Concepts of Causes of Asthma, *J. Michigan M. Soc.* **46** 328-330, 1947.

79 Cohen, S., and Wolf, H. L. Studies of the Autonomic Nervous System in "Atopic" Individuals, *J. Allergy* **18** 391-396, 1947.

80 Swanton, C. Asthma and Other Psycho-Physical Interrelations, *M. J. Australia* **1** 138-145, 1947.

81 Jimenez, Diaz, C., Lahoz, C., and Canto, G. The Allergens of Mill Dust Asthma in Millers, Farmers and Others, *Ann. Allergy* **5** 519-525, 1947.

(beetles), and, more rarely, Acarina, flour and substances similar to the allergens of house dust

In a further review of flour allergy, Schwartz⁸² gives an account of 35 cases. Tests showed reactions to oats in 23, to rye in 22, to wheat in 19 and to barley in 18. Of 12 patients tested, 6 gave positive and 6 negative reactions to administration of potassium bromide and 5 positive and 7 negative reactions to monochloramine. Forty-six per cent of the series reported allergic disease in the family, and 2 of them had other allergies. The sensitization time for the group is given as follows. In a series of 23 patients with bronchial asthma and vasomotor rhinitis, the average was 15.8 years for the asthma and 8.4 years for the rhinitis. For 10 patients with asthma alone the average was 15.7 years, and for 2 patients with vasomotor rhinitis alone it was 11.0 years. Desensitization treatment in this group is discussed, and it is emphasized that flour allergy is an occupational disease.

A rather extensive series of papers by various authors appeared under the title of "Mold Fungi in the Etiology of Respiratory and Allergic Diseases." In this group, Sellers and McKenzie⁸³ show that in West Texas molds are present throughout the year. In a series of 392 patients with inhalant allergies, 174 gave definite reactions to one or more mold extracts, and 33 reacted only to molds. Mold allergy was found to be especially prevalent in the age group of 1 to 20 years. Desensitization treatment was considered worth while.

Dutton⁸⁴ found evidence of infection with various nonpathogenic fungi in the bronchial secretions of a small group of persons with asthma and obtained positive reactions to intradermal and scratch tests with extracts of these fungi in some of the patients. Appropriate hypsensitization resulted in improvement of symptoms, which is said to have been striking in a few patients with no other sensitizations. Prince, Tatge and Morrow⁸⁵ report on the properties of extracts of molds made by various methods and tested on patients by a number of observers.

Morrow⁸⁶ reports a large series of observations on the occurrence of molds in various parts of the country. In particular, results from

82 Schwartz, M. Flour Allergy, *J Allergy* **18** 341-350, 1947.

83 Sellers, E. D., and McKenzie, E. Mold Fungi in the Etiology of Respiratory Allergic Diseases. VIII. Mold Allergy in West Texas—Clinical Observations, *Ann Allergy* **5** 455-457, 1947.

84 Dutton, L. O. Mold Fungi in the Etiology of Respiratory Allergic Diseases. VI. Intrinsic Fungus Factors in Relation to Asthma, *Ann Allergy* **5** 439-441, 1947.

85 Prince, H. E., Tatge, E. G., and Morrow, M. B. Mold Fungi in the Etiology of Respiratory Allergic Diseases. V. Further Studies with Mold Extracts, *Ann Allergy* **5** 434-438, 1947.

86 Morrow, M. B. Mold Fungi in the Etiology of Respiratory Allergic Diseases. VII. Further Survey Studies, *Ann Allergy* **5** 442-454, 1947.

Buffalo, Decatur, Ill, Memphis, Tenn, Galveston, Texas, and Pittsburgh are presented. Ten species seemed to be the dominant ones for all stations. These included *Alternaria*, *Homodendrum*, *Penicillium*, *Aspergillus*, *Pullularia*, *Torula*, *Fusarium*, *Trichoderma* and two organisms described as a sterile pale species and a sterile dark species.

Deamer and Graham⁸⁷ report a twelve month study in San Francisco and report no notable seasonal variation in atmospheric molds in that area.

Durham⁸⁸ has continued his work on volumetric studies of atmospheric allergens. He describes the methods used and gives an extensive list of resulting figures.

Hansen-Pruss and Leeper⁸⁹ emphasize the need of a variety of methods for demonstration of suspected drug sensitivity, which in many cases might be impossible by a single method. They list the variety of tests available under the following headings: (1) tests using the pure, unaltered drug as an antigen (patch test, intradermal test, tongue test, buccal mucous membrane test, conjunctival test, leukopenic test, readministration), (2) tests using a combination of the drug and serum protein (drug and serum in vitro and in vivo), (3) passive transfer tests (Prausnitz-Kustner test, oral and intravenous use of antigen), and (4) miscellaneous tests (blister fluid, use of fluid and drug as antigen for intravenous test, use of other body fluids and exudates).

Dragstedt⁹⁰ points out the characteristics of true allergic reactions to drugs. Thus, reactions characterized by asthma, migraine, dermatitis, angioneurotic edema or urticaria probably are allergic. A history of a sensitizing administration of the drug is suggestive, and true allergy is indicated when the reaction is alleviated by such drugs as epinephrine and diphenhydramine hydrochloride (benadryl hydrochloride®). Acute yellow atrophy, for instance, is probably not an allergic reaction, while granulocytopenia may or may not be.

Wright⁹¹ has found that nasal sensitivity, manifested by nasal congestion, can be produced by vasoconstrictors, the synthetic ones in particular. Relief in such cases is obtained promptly by discontinuance of the drug which is at fault.

87 Deamer, W. C., and Graham, H. W. Respiratory Mold Allergy, California Med 66 289-292, 1947

88 Durham, O. C. The Volumetric Incidence of Atmospheric Allergens V Spot Testing in the Evaluation of Species, J Allergy 18 231-238, 1947

89 Hansen-Pruss, O. C., and Leeper, W. E. Methods for the Objective Demonstration of Suspected Drug Sensitivity, Ann Allergy 5 541-545, 1947

90 Dragstedt, C. A. Idiosyncrasy to Drugs, J. A. M. A 135 133-136 (Sept 20) 1947

91 Wright, R. W. Nasal Sensitivity to Vasoconstrictors, Arch Otolaryng 46 330-334 (Sept) 1947

Ellis⁹² has found that the thiosalicylic radical is the usual sensitizing factor in merthiolate®. He adds that 50 per cent of the merthiolate®-sensitive group were also sensitive to the mercury radical.

Sensitivity to acetylsalicylic acid (aspirin®) was found in 45 persons with chronic asthma by Friedlaender and Feinberg,⁹³ who believe that it indicates the likelihood of sensitivities to other simple chemical substances. The patients referred to were chiefly in the middle age group.

Instances of other etiologic factors reported include a case of asthma due to ingestion of tragacanth U S P (Brown and Crepea⁹⁴) and a case of sudden collapse in a young man following the intramuscular administration of 50 mg of thiamine hydrochloride (Shapero and Gwinner⁹⁵). A fatality following a second spraying of the nose, pharynx and trachea with procaine hydrochloride is reported by Ahroon,⁹⁶ who states that death may have been due to aspiration, concentration of the solution by evaporation or allergy.

Hampton⁹⁷ reports 2 cases of anaphylactic shock following parenteral injection of typhus vaccine prepared from chick embryos, and Curphey⁹⁸ cites a fatal reaction in a 3½ year old girl to influenza virus vaccine.

Reports on the role of the sulfonamide drugs and antibiotics in the etiology of allergies continue to accumulate. The possible relation of the sulfonamide drugs to periarteritis nodosa suggested by Harbert and McPherson⁴² and Goldsmith⁴³ and a case of glaucoma following sulfathiazole treatment (Fritz and Kesert³⁹) have already been referred to.

Sulzberger and his associates⁹⁹ have carefully studied the sensitization produced by topical application of the sulfonamide drugs in the form of creams in 254 men under standard conditions. They conclude that the sulfonamide compounds fall into the following order of increasing sensitizing potentials corresponding to their water solubilities

92 Ellis, F. A. The Sensitizing Factor in Merthiolate, *J Allergy* **18** 212-213, 1947

93 Friedlaender, S., and Feinberg, S. M. Aspirin Allergy: Its Relationship to Chronic Intractable Asthma, *Ann Int Med* **26** 734-740, 1947

94 Brown, E. B., and Crepea, S. B. Allergy (Asthma) to Ingested Gum Tragacanth, *J Allergy* **18** 214-215, 1947

95 Shapero, W., and Gwinner, M. W. Sensitivity to Thiamine Hydrochloride: Report of a Case, *Ann Allergy* **5** 349-352, 1947

96 Ahroon, W. A. Report of a Death from Pontocaine Hydrochloride, *Laryngoscope* **56** 320-323, 1946

97 Hampton, S. F. Anaphylactic Shock in Egg-Sensitive Individuals Following Vaccination with Typhus Vaccine, *J Lab & Clin Med* **32** 109-117, 1947

98 Curphey, T. J. Fatal Reaction Due to Influenza Vaccine, *J A M A* **133** 1062-1064 (April 12) 1947

99 Sulzberger, M. B., Fanot, A., Baer, R. L., and Lowenberg, C. Sensitization by Topical Application of Sulfonamides, *J Allergy* **18** 92-103 1947

sulfadiazine, sulfathiazole, sulfanilamide and sodium sulfadiazine. Cross sensitization was obtained with a significant frequency, and superficial damage to the skin at the site of topical application greatly increased the incidence of sensitization. In conclusion, they warn that sensitizing external application of sulfonamide drugs results in increased danger of both cutaneous and general reactions from the subsequent oral administration of the same or a related drug.

A case of sensitization to sulfadiazine, in which passive transfer was successfully carried out, is reported by Whittemore and de Gara.¹⁰⁰ Sensitization in this case had apparently occurred during previous treatment for furunculosis. Sherman and Cooke¹⁰¹ also proved the existence of antibodies by passive transfer tests in patients with sensitivity to sulfadiazine.

Friedman¹⁰² reports cases of sulfadiazine poisoning with pemphigoid lesions.

Ballenger,¹⁰³ on the other hand, found an incidence of sensitivity of less than 0.5 per cent after application of sulfathiazole, sulfanilamide and sulfadiazine powders by insufflation to the mucous membrane of the upper respiratory tract in 1,500 patients with various acute infections of the nose and throat.

Hopkins and Lawrence¹⁰⁴ found that in a series of patients treated with penicillin for cutaneous infections, 11 per cent had urticaria, erythematovesicular lesions or dermatitis and that 13 per cent of patients treated with penicillin ointment were sensitized, as shown by patch tests. Sensitization was demonstrable in 27 per cent with eczematoid lesions. There were, however, no severe generalized reactions, and sensitization was often localized and transient. Less than 1 per cent of patients showed sensitization sufficiently severe to preclude later systemic treatment with penicillin.

Three cases of the delayed serum type of reaction to penicillin occurring in one family are reported by Kendig and Toone.¹⁰⁵ The

100 Whittemore, A. L., and de Gara, P. F. Sulfadiazine Sensitivity. An Unusual Case with Successful Passive Transfer, *J. Allergy* **18** 382-384, 1947.

101 Sherman, W. B., and Cooke, R. A. Sulfadiazine Sensitivity with Demonstrable Skin Sensitizing Antibody in the Serum, *Am. J. Med.* **2** 588-593, 1947.

102 Friedman, B. Therapeutic Sulfadiazine Poisoning, with Pemphigoid Lesions. Conjunctival Changes, *Arch. Ophth.* **38** 796-805 (Dec.) 1947.

103 Ballenger, H. C. Sensitivity from Insufflation of the Powdered Sulfonamide Compounds in Acute Infections of the Nose and Throat, *Arch. Otolaryng.* **46** 52-57 (July) 1947.

104 Hopkins, J. G., and Lawrence, H. Sensitization to Penicillin, *J. Allergy* **18** 251-262, 1947.

105 Kendig, E. L., and Toone, E. C. Delayed Serum Type of Reaction to Penicillin. Report of Three Cases in One Family, *South. M. J.* **40** 697-698, 1947.

reactions were all moderate in form, with malaise, arthralgia and urticaria

Mears and State¹⁰⁶ describe a case in which local use of penicillin in a hypersensitive patient produced a rapid inflammatory and necrotizing lesion resembling Arthus' phenomenon. The solution in this case was used on an open wound.

Brown¹⁰⁷ reports a case of glossodynia and exfoliation of papillary filaments after the oral administration of penicillin.

A case of urticaria and nasal congestion and another of dermatitis, nasal congestion and photophobia in nurses handling penicillin are presented by MacInnis¹⁰⁸. One of these nurses gave a history of penicillin sensitivity following treatment, but the other had no history of ever receiving penicillin.

Barefoot and Orlandsky¹⁰⁹ feel that some reactions to penicillin may be due to impurities, and they cite the case of a patient who gave no reaction to crystalline penicillin after having had repeated reactions to the crude drug.

Hewitt and Curry¹¹⁰ have found a histamine-like substance in streptomycin which produced typical effects, relieved by diphenhydramine hydrochloride (benadryl hydrochloride®), in a group of patients. They feel that the evidence indicates that histamine may be a contaminant in impure streptomycin.

ANTI-HISTAMINIC SUBSTANCES

A general review of the pharmacology of the antihistaminic drugs is published by Loew,¹¹¹ and another, briefer, general discussion, by Arbesman.¹¹² Arbesman points out that these drugs owe their effectiveness to the altering of the end product of the allergen-antibody

106 Mears, F. B., and State, D. Arthus Phenomenon Induced by Local Application of Penicillin, *Minnesota Med* **30** 517-518, 1947.

107 Brown, R. L. Glossodynia and Exfoliation of Papillae Filaments After Oral Administration of Penicillin, *Arch Otolaryng* **45** 355-356, 1947.

108 MacInnis, K. B. Allergic Reactions from Handling Penicillin, *Ann Allergy* **5** 102-104, 1947.

109 Barefoot, S. W., and Orlandsky, S. Report of a Patient Tolerating Crystalline Penicillin Without Reaction After Repeated Reactions to Crude Penicillin, *North Carolina M J* **8** 82-83, 1947.

110 Hewitt, W. L., and Curry, J. J. Pharmacodynamic Effect in Man of Streptomycin Containing a Histamine-Like Factor, *J Lab & Clin Med* **32** 41-46, 1947.

111 Loew, E. R. Pharmacology of Antihistamine Compounds, *Physiol Rev* **27** 542-573, 1947.

112 Arbesman, C. E. The Pharmacology, Physiology and Clinical Evaluation of the New Antihistaminic Drugs (Pyribenzamine and Benadryl), *New York State J Med* **47** 1775-1781, 1947.

reaction, which is histamine. Other investigators, however, are in doubt whether histamine is actually the mediating substance responsible for allergic reactions, as demonstrated by studies with antihistaminic drugs. Last and Loew,¹¹³ working with rabbits, found that the effect of injected histamine in increasing capillary permeability, as shown by the trypan blue test, was prevented or diminished by administration of diphenhydramine and pyranisamine (neo-antergan®). They found, however, that intradermal injections of horse serum and other substances produce a trypan blue reaction not modified by diphenhydramine (benadryl®) and therefore conclude that histamine is not a major factor in the production of such increased capillary permeability. They do not feel, however, that histamine can be excluded entirely in antigen-antibody reactions.

Dreisbach¹¹⁴ failed to obtain protection against the development of the Arthus type of cutaneous sensitivity induced by penicillin in horse serum with diphenhydramine (benadryl hydrochloride®) or tripeleennamine hydrochloride (pyribenzamine hydrochloride®), even when they were mixed with the antigen given. When mixed with histamine, they did prevent reactions. He suggests that the clinical effects of these drugs may be subjective and dependent on central and peripheral depression.

Schiller and Lowell¹¹⁵ measured changes in vital capacity of 3 asthmatic patients subjected to the inhalation of aerosolized pollen extracts and to solutions of histamine and acetyl-beta-methylcholine. The effects of various drugs in modifying responses were studied, and it was found that neither atropine nor tripeleennamine hydrochloride influenced them. They conclude that neither acetylcholine nor histamine is a determining factor in the production of pollen-induced asthmatic attacks.

Levy and Seabury¹¹⁶ made spirometric studies on 16 patients with asthma and found that at thirty minutes and one hour after the oral administration of 100 mg of diphenhydramine hydrochloride there were

113 Last, M. R., and Loew, E. R. Effect of Antihistamine Drugs on Increased Capillary Permeability Following Intradermal Injections of Histamine, Horse Serum and Other Agents in Rabbits, *J. Pharmacol. & Exper. Therap.* **89** 81-91, 1947.

114 Dreisbach, R. H. Failure of Benadryl and Pyribenzamine in Experimental Skin Sensitization to Penicillin and Horse Serum, *J. Allergy* **18** 397-401, 1947.

115 Schiller, I. W., and Lowell, F. C. The Effect of Drugs in Modifying the Response of Asthmatic Subjects to Inhalation of Pollen Extracts as Determined by Vital Capacity Measurements, *Ann. Allergy* **5** 564-566, 1947.

116 Levy, L., and Seabury, J. H. Spirometric Evaluation of Benadryl in Asthma, *J. Allergy* **18** 244-250, 1947.

no consistent changes in vital capacity, tidal air, minute ventilation, expiratory differential (the value in centimeters of air of the difference between the expiratory level of a vital capacity breath and the expiratory level of the preceding normal breath), respiratory rate or degree of emphysema. In 3 of 6 patients deriving subjective relief, the spirometric data were opposed to the subjective report. The spirometric measurements were increased with no increases in respiratory rate, in 5 patients given epinephrine and aminophylline. One patient went into status asthmaticus after administration of diphenhydramine hydrochloride (benadryl®). Levy and Seabury believe that there are two phases in the subsidence of asthma separated by a variable interval (1) the initial alleviation of bronchial spasm and (2) the return of the respiratory effort to a resting level.

Campbell, Baronofsky and Good¹¹⁷ found that, while diphenhydramine hydrochloride protected rabbits against histamine shock, it did not protect them against anaphylactic shock induced with egg white. Guinea pigs actively sensitized to egg white were not protected against anaphylaxis induced by intraperitoneal administration of the antigen.

On the other hand, Marcus¹¹⁸ concludes that the protective effect of tripelennamine hydrochloride and diphenhydramine hydrochloride is quantitatively related to administered doses of egg white and that these results are important evidence that histamine plays a major role in anaphylaxis.

Mayer¹¹⁹ is also of the opinion that data derived from experiments with antihistaminic substances support the theory that histamine (or a histamine-like substance) is an important factor in anaphylaxis and in other manifestations not previously associated with histamine.

Mayer, Brousseau and Eisman¹²⁰ protected guinea pigs against histamine intoxication and anaphylactic shock with administration of tripelennamine hydrochloride inhaled in the form of an aerosol. The possible therapeutic value of tripelennamine hydrochloride administered in this way is mentioned, since the effective doses are so small that side effects should be kept at a minimum.

117 Campbell, B., Baronofsky, I. D., and Good, R. A. Benadryl Effects on Anaphylactic and Histamine Shock in Rabbits and Guinea Pigs, *Proc Soc Exper Biol & Med* **64** 281-283, 1947.

118 Marcus, S. Quantitative Aspects of Inhibition of Anaphylactic Shock in Guinea Pigs, *Proc Soc Exper Biol & Med* **66** 181-184, 1947.

119 Mayer, R. L. Antihistaminic Substances and Experimental Sensitization, *Ann Allergy* **5** 113-125, 1947.

120 Mayer, R. L., Brousseau, D., and Eisman, P. C. Pyribenzamine Aerosol Inhalation Influence on Anaphylaxis, *Proc Soc Exper Biol & Med* **64** 92-96, 1947.

Gelvin, Elias and McGavack¹²¹ found that diphenhydramine hydrochloride had no effect on the permeability of the meningeal capillaries and produced no alteration in the cerebrospinal fluid. They therefore conclude that any effects following the administration of diphenhydramine hydrochloride to human subjects are due to other modes of action of the drug.

Rose, Feinberg, Friedlaender and Feinberg¹²² studied the comparative antianaphylactic properties of several of the antihistamine drugs, including diphenhydramine hydrochloride, tripeleminamine hydrochloride, dimethyl aminoethylbenzyl aniline (antergen®) and pyranisamine (neo-antergan®) all of which showed essentially similar effects against a single lethal dose of histamine. It was further found that amounts of these drugs which had no effect on the contractions of a sensitized strip of guinea pig intestine due to histamine inhibited anaphylactic contractions.

Further demonstrations of the antihistaminic activity of diphenhydramine hydrochloride are reported by Cohen and co-workers,¹²³ who show the effectiveness of the drug in raising the histamine threshold of the human skin, and that of tripeleminamine hydrochloride, by Aaron and Abramson,¹²⁴ who demonstrated inhibition of histamine wheal formation.

Mayer and Kull¹²⁵ showed that the effect of hyaluronidase in increasing allergic inflammatory lesions of the skin was counteracted by tripeleminamine hydrochloride.

Goodman and Coonrad¹²⁶ were able to prevent headache induced with histamine phosphate in all of a group of 34 persons subject to various types of headache with 100 mg of diphenhydramine hydrochloride given orally one hour before the experiment. Of 54 patients seen primarily because of headache, histamine phosphate reproduced

121 Gelvin, E. P., Elias, H., and McGavack, T. H. The Effect of Dimethyl-aminoethyl Benzhydryl Ether Hydrochloride (Benadryl) upon Permeability of Meningeal Capillaries, *J. Pharmacol. & Exper. Therap.* **89** 101-105, 1947.

122 Rose, J. M., Feinberg, A. R., Friedlaender, S., and Feinberg, S. M. Histamine Antagonists. VII. Comparative Antianaphylactic Activity of Some New Antihistaminic Drugs, *J. Allergy* **18** 149-155, 1947.

123 Cohen, M. B., Friedman, H. J., Zoris, J., Burke, M., and Abraham, L. E. The Effect of Beta-Dimethylaminoethyl-Benzhydryl-Ether-Hydrochloride on the Histamine Threshold of the Human Skin, *J. Allergy* **18** 32-35, 1947.

124 Aaron, T. H., and Abramson, H. A. Inhibition of Histamine Whealing in Human Skin by Pyribenzamine Hydrochloride Using Iontophoretic Technique, *Proc. Soc. Exper. Biol. & Med.* **65** 272-273, 1947.

125 Mayer, R. L., and Kull, F. C. Influence of Pyribenzamine and Antistine on the Action of Hyaluronidase, *Proc. Soc. Exper. Biol. & Med.* **66** 392-398, 1947.

126 Goodman, E. G., and Coonrad, R. W. Prophylactic Effect of Benadryl on Experimental Histamine Headache, *J. Allergy* **18** 402-407, 1947.

symptoms in 31 Of 18 patients given diphenhydramine hydrochloride before a subsequent injection of histamine phosphate, the headache was prevented in 15 and was mild in 1 Results were questionable in 2 others

Perry and Horton¹²⁷ found that 12.5 to 25 mg of tripeleannamine hydrochloride given intravenously almost entirely prevented headaches following the intravenous administration of 0.05 mg of histamine base They obtained no consistent effect of tripeleannamine hydrochloride on the increase of gastric acidity induced with histamine They do not recommend the intravenous administration of tripeleannamine hydrochloride clinically because of side effects

Using electroalgesimetric determinations, Leavitt and Code¹²⁸ showed that diphenhydramine hydrochloride has anesthetic potencies in dilutions of 1:500, 1:1,000, 1:5,000, 1:10,000 and 1:20,000, equivalent, respectively, to solutions of procaine hydrochloride of 1:200, 1:400, 1:800, 1:1,600 and 1:3,200 In concentrations greater than 1:500 diphenhydramine hydrochloride proved to be extremely irritating and caused necrosis and ulceration in 4 of 10 subjects

Of other antihistaminic drugs, one, thonzylamine hydrochloride (neohetramine hydrochloride[®], N,N-dimethyl-N'-[*p*-methoxybenzyl]-N'-[2-pyrimidyl]-ethylenediamine hydrochloride) was investigated by Reinhard and Scudi¹²⁹ and Dreyer and Harwood¹³⁰ Reinhard and Scudi, on the basis of intraperitoneal tests on mice found it to be half as toxic as other antihistaminic drugs Marked activity against the effects of histamine on bronchioles and capillaries was demonstrated, but quantitative estimates of the effect were said to vary with the method of testing The drug protected guinea pigs against anaphylactic shock, and therapeutic value is suggested Dreyer and Harwood¹³⁰ found thonzylamine hydrochloride to be highly antihistaminic and to possess atropine-like properties

The compound N-(2-pyridyl)-N-(2-thenyl)-N', N-dimethylethylenediamine hydrochloride, designated as 01013, was found by Lee, Din-

127 Perry, E. L., and Horton, B. T. Use of Pyribenzamine in Prevention of Histamine-Induced Gastric Acidity and Headache and in Treatment of Hypersensitiveness to Cold, *Am. J. M. Sc.* **214** 553-558, 1947

128 Leavitt, M. D., and Code, C. F. Anesthetic Action of Beta Dimethyl-aminoethyl Benzhydryl Ether Hydrochloride (Benadryl) in the Skin of Human Beings, *Proc. Soc. Exper. Biol. & Med.* **65** 33-38, 1947

129 Reinhard, J. F., and Scudi, J. V. Pharmacological Characteristics of Neohetramine, a New Antihistaminic Drug, *Proc. Soc. Exper. Biol. & Med.* **66** 512-515, 1947

130 Dreyer, N. B., and Harwood, D. Pharmacological Characteristics of Neohetramine, a New Antihistaminic Drug, *Proc. Soc. Exper. Biol. & Med.* **66** 515-516, 1947

widdie and Chen¹³¹ to be a potent antihistaminic agent through experiments with guinea pigs and cats and on guinea pig intestine. It is thought to be of possible value in the treatment of hay fever. Feinberg and Bernstein¹³² also demonstrated its antihistaminic properties and found that it produces fairly common side reactions, chiefly sedation. These effects are stated to be about equal to those of tripeleennamine hydrochloride and definitely less marked than those of diphenhydramine hydrochloride. Clinical tests indicate an effectiveness approaching, but not equaling, that of tripeleennamine hydrochloride.

Halpern and his co-workers (Halpern¹³³ and Hamburger, Halpern and de Bray¹³⁴) studied a new series of antihistaminic drugs derived from thioldiphenylamine. Two of them (3015 R P and 3277 R P) were found to be powerfully antihistaminic. The latter is said to protect guinea pigs against 1,500 lethal doses of histamine, and 0.1 mg protects against fatal anaphylactic shock. The drugs were found to be less toxic and more active than previous antihistaminic substances.

A large group of clinical reports on the antihistaminic drugs appeared during 1947. A majority of these reports deal with tripeleennamine and diphenhydramine. These will be considered first and reports on other drugs will be covered later.

Reinstein and McGavack¹³⁵ outline a technic for the administration of diphenhydramine hydrochloride, beginning with an initial dose of 150 mg daily. The dose is increased to 600 mg over a ten day period and the increase is stopped as soon as improvement begins. Administration of the dose attained is then continued for two weeks and then stopped. If symptoms recur, treatment is resumed. In children a similar program is followed with a maximum dose of 2 mg per pound (0.5 Kg) of weight. It is suggested that side reactions be ignored unless they are severe.

131 Lee, H. M., Dinwiddie, W. G., and Chen, K. K. The Antihistamine Action of N-(2-Pyridyl)-N-(2-Thienyl)-N'-N'-Dimethylethylenediamine Hydrochloride, *J. Pharmacol. & Exper. Therap.* **90** 83-87, 1947.

132 Feinberg, S. M., and Bernstein, T. B. Histamine Antagonists. VIII. N-(α -Pyridyl)-N-(α -Thienyl)-N'-N'-Dimethylethylenediamine, a New Antihistaminic Compound, Experimental and Clinical Experiences, *J. Lab. & Clin. Med.* **32** 1370-1373, 1947.

133 Halpern, B. N. Experimental Research on a New Series of Chemical Substances with Powerful Antihistaminic Activity. The Thioldiphenylamine Derivatives, *J. Allergy* **18** 263-272, 1947.

134 Hamburger, J., Halpern, B., and deBray, C. Cited in Research on a New Series of Synthetic Antihistaminics, Foreign Letters (Paris), *J. A. M. A.* **133** 960 (March 29) 1947.

135 Reinstein, H., and McGavack, T. H. Benadryl. Technique for Its Administration, *New York State J. Med.* **47** 1601-1603, 1947.

Goldstein¹³⁶ reports on 79 allergic patients treated with diphenhydramine hydrochloride, 71 of them between the ages of 2 and 16 years. He obtained excellent improvement in 76 per cent, good improvement in 10 per cent, fair to poor results in 6 per cent and no improvement in 8 per cent.

Pennock¹³⁷ had poor results with administration of diphenhydramine hydrochloride in his series of cases and feels that the dose used may have been inadequate.

In the treatment of hay fever Logan¹³⁸ reports some benefit in 11 of 13 children receiving doses of 10 to 450 mg of diphenhydramine hydrochloride per day. Lockey¹³⁹ found diphenhydramine hydrochloride valuable in the treatment of hay fever, and similar results are reported by Barnett and his co-workers¹⁴⁰. Farmer and Spickschen¹⁴¹ obtained good results in 23 of 45 cases, fair results in 11 cases and poor results in 11 cases. Walton and Kristjansson-MacDonell¹⁴² obtained marked benefit with diphenhydramine hydrochloride in 16 of 18 cases of hay fever.

Loveless¹⁴³ has found both diphenhydramine and tripeleminamine valuable in the treatment of hay fever, and in another paper (Loveless and Brown¹⁴⁴) reports that the two drugs were about equally effective in 23 of 33 cases. Of the remaining 10 cases, response was better to tripeleminamine hydrochloride in 5 and to diphenhydramine hydrochloride in 5.

136 Goldstein, H. Benadryl Treatment of Allergic Patients. Seventy-Nine Cases, *J Pediat* **30** 41-44, 1947.

137 Pennock, L. L. Benadryl. Clinical Experiences in Allergic States, *Pennsylvania M J* **50** 609-613, 1947.

138 Logan, G. B. The Use of Benadryl in the Treatment of Certain Allergic Diseases of Children, *Ann Allergy* **5** 105-112, 1947.

139 Lockey, S. D. Benadryl. A Clinical Evaluation Based on One Hundred and Seventy-One Cases Studied, *Ann Allergy* **5** 420-425, 1947.

140 Barnett, S. E., Goss, S. B., Fox, L., and Cohen, H. H. Benadryl in Hay Fever, Asthma, Vasomotor Rhinitis, and in Mixed Allergic Groups. Further Observations, *Eye, Ear, Nose & Throat Monthly* **26** 199-205, 1947.

141 Farmer, L., and Spickschen, H. Benadryl. Synthetic Antihistamine Compound for Symptomatic Treatment of Allergic Diseases, *New York State J Med* **47** 1119-1121, 1947.

142 Walton, C. H. A., and Kristjansson-MacDonell, J. A. Antihistamine Drugs, *Canad M A J* **56** 162-169, 1947.

143 Loveless, M. H. Therapeutic and Side Effects of Pyribenzamine and Benadryl, *Am J Med* **3** 296-308, 1947.

144 Loveless, M. H., and Brown, H. A Comparison Between the Clinical Effects of Pyribenzamine and Those of Benadryl, *New England J Med* **237** 501-504, 1947.

Engelsher¹⁴⁵ made three day trial treatments with tripeleannamine hydrochloride and diphenhydramine hydrochloride on 193 patients with hay fever or asthma, or both. In 127 patients symptoms were unchanged, and the drying effect produced cough, and even asthma, in some patients who had had no previous thoracic symptoms. He feels that these drugs are far less valuable than standard medication.

Wagner¹⁴⁶ emphasizes the value of diphenhydramine and tripeleannamine in the symptomatic relief of allergic conditions and reports 38 cases of hay fever treated with these drugs, with relief in 24, partial relief in 3 and no relief in 11. Of 44 patients under hyposensitization treatment who had symptoms, 38 were relieved with antihistaminic drugs.

Henderson and Rose¹⁴⁷ had their best results with tripeleannamine hydrochloride in treatment of hay fever, with benefit to 47 of 61 patients. Similar results are reported by Levin,¹⁴⁸ who obtained improvement in 18 of 28 patients. Levin feels that results with diphenhydramine hydrochloride are slightly better than those with tripeleannamine hydrochloride.

Fuchs, Schulman and Strauss¹⁴⁹ consider tripeleannamine hydrochloride valuable for the relief of symptoms of hay fever but point out that relief is temporary and in no way concerned with the antigen-antibody reaction. They have found tripeleannamine hydrochloride particularly useful when administered prior to the injection treatment, since larger doses are made possible and maximum doses almost twice those otherwise tolerated can be used.

Leibowitz, Kurtz and Schwartz¹⁵⁰ obtained relief in 9 of 21 patients with hay fever treated with tripeleannamine hydrochloride alone, in 35 of 47 treated with tripeleannamine hydrochloride and desensitization and in 10 of 18 with desensitization alone. Arbesman, Cohen and Osgood¹⁵¹ report that tripeleannamine hydrochloride and injection therapy gave

145 Engelsher, D. L. Antihistaminic Drugs in Asthma and Hay Fever, New York State J. Med. **47** 1696, 1947.

146 Wagner, H. C. Symposium on Advances in Clinical Medicine. Use of New Antihistaminic Substances (Especially Benadryl and Pyribenzamine) in Allergic Disorders, M. Clin. North America **31** 43-51, 1947.

147 Henderson, A. T., and Rose, B. Pyribenzamine in the Treatment of Allergy, Canad. M. A. J. **57** 136-140, 1947.

148 Levin, S. J. Clinical Results with Pyribenzamine, J. Michigan M. Soc. **46** 85-86, 1947.

149 Fuchs, A. M., Schulman, P. M., and Strauss, M. B. Clinical Studies with Pyribenzamine (N'-Pyridyl-N'-Benzyl-N-Dimethylendiamine) in Hay Fever, J. Allergy **18** 385-390, 1947.

150 Leibowitz, H., Kurtz, I. M., and Schwartz, E. Pyribenzamine in the Treatment of Hay Fever, New York State J. Med. **47** 989-991, 1947.

151 Arbesman, C. E., Cohen, V. L., and Osgood, H. Pyribenzamine Versus Specific Hyposensitization in the Treatment of Pollinosis. A Comparative Study, J. Allergy **18** 311-324, 1947.

relief of symptoms in 95 of 242 patients. In clinic patients results obtained with either tripeleennamine hydrochloride or specific hypsensitization were about equal.

In treatment of vasomotor rhinitis Lockey¹³⁹ reports valuable results with diphenhydramine hydrochloride, and Logan¹³⁸ obtained some benefit in 16 of 18 children with the drug.

Tripeleennamine hydrochloride and/or diphenhydramine hydrochloride has been reported to be of value in treatment of urticaria by Logan¹³⁸, Lockey¹³⁹, Loveless¹⁴⁰ and Loveless and Brown¹⁴⁴.

Peterson and Bishop¹⁵² completely controlled serum sickness in 9 of 10 children, from 2 months to 8 years of age, with doses of 8 mg of diphenhydramine hydrochloride per pound of body weight. The tenth child was much benefited.

Perry and Horton¹²⁷ found tripeleennamine hydrochloride of some value in 3 cases of hypersensitiveness to cold.

Lockey¹³⁹ found diphenhydramine of no value in treatment of migraine, seasickness, dysmenorrhea, or erythema nodosum (1 case) and of little value in treatment of atopic eczema.

In treatment of bronchial asthma, reports are consistently unfavorable, or at best inconclusive. McGavack, Elias and Boyd¹⁵³ consider diphenhydramine a valuable antihistaminic agent and a potent sedative but report only fair results in the treatment of asthma. Lockey¹³⁹ found that the drug had limited value in some cases of intractable asthma but that it did not relieve the asthma of most patients. Barnett, Goss, Fox and Cohen¹⁴⁰ had poor results in 3 cases of severe asthma. Logan¹³⁸ reports some degree of benefit in 6 of 7 children with a single attack of asthma and in 16 of 17 children with multiple attacks. Fernberg and Friedlaender¹⁵⁴ found tripeleennamine only moderately effective in treatment of bronchial asthma, while Loveless and Brown¹⁴⁴ report that mild bronchospasm was relieved but that severe asthma was not.

It is generally agreed that both tripeleennamine and diphenhydramine frequently produce troublesome side reactions and that these may in some degree limit the value of the drugs. Gruhzit and Fiskén¹⁵⁵

152 Peterson, J. C., and Bishop, L. K. Treatment of Serum Sickness with Benadryl, *J. A. M. A.* **133** 1277-1280 (April 26) 1947.

153 McGavack, T. H., Elias, H., and Boyd, L. J. Pharmacologic and Clinical Experiences with Dimethylaminoethyl Benzhydrol Ether Hydrochloride (Benadryl), *Am. J. M. Sc.* **213** 418-434, 1947.

154 Fernberg, S. M., and Friedlaender, S. Histamine Antagonists. Pyribenzamine in Symptomatic Treatment of Allergic Manifestation, *Am. J. M. Sc.* **213** 58-60, 1947.

155 Gruhzit, O. M., and Fiskén, R. A. A Toxicologic Study of Two Histamine Antagonists of the Benzhydrol Alkamine Ether Group, *J. Pharmacol. & Exper. Therap.* **89** 227-251, 1947.

investigated the basic effects of diphenhydramine hydrochloride and another antihistaminic drug, A-446 (2-morpholinoethyl benzhydryl ether hydrochloride). They found that both drugs were well tolerated in appropriate doses for six months. Toxic effects noted included excitement, spastic ataxia, extreme irritability, painful hyperesthesia, convulsive attacks and respiratory and myocardial embarrassment. Barbiturates controlled the excitement, but not respiratory or cardiac depression.

Goldstein¹³⁶ added 25 per cent of pyridoxine hydrochloride to diphenhydramine and found that most side effects were overcome. In 2 cases in which the effect was not obtained, 50 mg of nicotinamide was immediately successful.

Of Pennock's¹³⁷ series of patients, 57 per cent had side reactions to diphenhydramine hydrochloride and 5 per cent had to discontinue use of the drug. There was, however, no instance of addiction, cumulative effect, development of tolerance, sensitization or serious toxic effect.

Farmer and Spickschen¹⁴¹ found side reactions in one third of 45 patients with hay fever treated with diphenhydramine hydrochloride. Walton and Kristjanssen-MacDonell¹⁴² encountered side reactions in 14 of 18 cases of hay fever and feel that remote toxic effects must be considered and that allergy to antihistaminic drugs is a possibility. Side reactions to diphenhydramine are also reported by McGavack, Elias and Boyd¹⁵³ and by Logan.¹³⁸ Loveless and Brown,¹⁴⁴ in comparing diphenhydramine with tripeleennamine, report that side effects (mostly sedation) occurred in 61 per cent of patients treated with diphenhydramine and in 20 per cent treated with tripeleennamine. Wagner¹⁴⁶ and Levin¹⁴⁸ also report side reactions with tripeleennamine and diphenhydramine, and Levin has found them more frequently with the latter drug.

Henderson and Rose¹⁴⁷ encountered side reactions to tripeleennamine, and 2 of 138 patients had to discontinue therapy. Leibowitz and his associates¹⁵⁰ reported side reactions in 25 of 68 patients treated with tripeleennamine hydrochloride.

A number of cases of unusual and serious side reactions to diphenhydramine and tripeleennamine have been reported. Harris and Shure¹⁵⁶ describe a case of eczematoid dermatitis following administration of tripeleennamine hydrochloride. This reaction is considered allergic, since the effect is unconnected with the pharmacologic properties of the drug. Two cases of dermatitis occurring during treatment with tripeleennamine, with recovery on withdrawal of the drug, are reported by

¹⁵⁶ Harris, M. C., and Shure, N. Eczematoid Dermatitis Following Ingestion of "Piribenzamine Hydrochloride," *N. N. R. Tablets*, *J. Allergy* **18** 408-412, 1947.

Epstein¹⁵⁷ Sternberg¹⁵⁸ records a case of hysteria in a young woman given a daily dose of 350 mg of diphenhydramine hydrochloride, with recovery when the administration was stopped. Weil¹⁵⁹ presented a case of excitement followed by irrationality in a 3½ year old boy given diphenhydramine hydrochloride. Recovery in this case was also prompt. The case of a woman aged 26 who received 300 mg of diphenhydramine hydrochloride over a three day period, and in whom developed palpitation, malaise, drowsiness, heartburn, nausea and, eventually, unconsciousness, is described by Geiger, Rosenfield and Hartman¹⁶⁰. A case of hypertension following administration of diphenhydramine hydrochloride is reported by Gelfand,¹⁶¹ and one of a prolonged reaction, still present after three months, by Schwartzberg and Willerson¹⁶².

Administration of tripeleminamine hydrochloride was followed by granulocytopenia in a woman of 74 and was considered the probable cause in this case, reported by Blanton and Owens¹⁶³.

In a few cases diphenhydramine hydrochloride was given in massive doses. One was that of an 18 year old girl who increased her dose to 2,000 mg in three days after experiencing good results in hay fever and asthma. She became drowsy and irrational. The temperature, pulse and respiratory rate remained normal, and she recovered in forty-eight hours. Treatment consisted of forcing fluids, especially strong coffee (Borman¹⁶⁴). Duerfeldt¹⁶⁵ reports the suicide of a girl aged 13 who took 30 capsules (50 mg each) of diphenhydramine hydrochloride and the recovery of an asthmatic patient aged 56 who misunderstood directions and took 50 similar capsules.

157 Epstein, E. Dermatitis Occurring During Therapy with Tripeleminamine Hydrochloride ("Pyribenzamine Hydrochloride"), *J A M A* **134** 782 (June 28) 1947.

158 Sternberg, L. Unusual Side Reaction of Hysteria from Benadryl, *J Allergy* **18** 417, 1947.

159 Weil, H R. Unusual Side Effect from Benadryl, *J A M A* **133** 393 (Feb 8) 1947.

160 Geiger, J, Rosenfield, S Z, and Hartman, D L. Unusual Reaction Following Benadryl Administration, *J A M A* **133** 392 (Feb 8) 1947.

161 Gelfand, H H. Hypertension Following Benadryl, *Queries and Minor Notes*, *J A M A* **134** 1278 (Aug 9) 1947.

162 Schwartzberg, S, and Willerson, D. Prolonged Reaction to Benadryl, *J A M A* **133** 393-394 (Feb 8) 1947.

163 Blanton, W B, and Owens, M E B, Jr. Granulocytopenia Due Probably to "Pyribenzamine," *J A M A* **134** 454-455 (May 31) 1947.

164 Borman, M C. Danger with Benadryl of Self-Medication and Large Dosage, *J A M A* **133** 394-395 (Feb 8) 1947.

165 Duerfeldt, T H. Acute Benadryl Poisoning, *Northwest Med* **46** 781-782, 1947.

Of the other antihistaminic drugs, one, phenindamine (thephorin®), (2-methyl-9-phenyl-2,3,4,9-tetrahydro-1-pyridindene hydrogen tartrate), was tried clinically by Reynolds and Horton,¹⁶⁶ who had excellent results in 17 of 22 cases of hay fever. In these 17 cases, the symptoms were moderately severe. In 2 of 4 other cases with severe symptoms 50 per cent relief was obtained. One patient had no relief, and 1 complained of drowsiness. Animal studies indicated that phenindamine is antagonistic to histamine.

Kallos¹⁶⁷ found antistin (2-phenylbenzylaminomethyl-imidazolin), a drug little used in the United States, valuable in the treatment of allergic dermatosis, serum disease, Menière's syndrome, Horton's syndrome (histamine cephalalgia) and in some cases of seasonal perennial allergic rhinitis.

The drug called 01013 by Lee and co-workers¹⁸¹ was found most effective by Pierce and Mothersill¹⁶⁸ in the treatment of rhinitis due to pollen, acute urticaria and histamine-induced headache. Of 21 cases of ragweed hay fever, complete relief was obtained in 15 cases, moderate relief in 3 cases and none in 3 cases. There were 5 instances of side effects, dizziness, depression and light-headedness. A dose of 50 to 400 mg daily was employed.

Feinberg and Bernstein¹⁸² found the same drug a little less effective than tripeleminamine hydrochloride. Side reactions occurred less frequently than with diphenhydramine and in selected persons are said to be less disturbing than those of tripeleminamine.

Ratner¹⁶⁹ evaluates the antihistaminic drugs and their place in therapeutics and points out that histamine is not the proved cause of allergic reactions and that these drugs have not been proved to be antihistaminic. He feels that many allergic episodes are self limited and that spontaneous termination may frequently be confused with beneficial results from use of antihistaminic substances. He considers them valuable in cases of urticaria and hay fever in allaying pruritus and lacrimal and nasal discharge but points out what the literature cited indicates, namely, that they are not effective in treatment of asthma or eczema. They deserve a place as symptomatic remedies but are in no sense cures.

¹⁶⁶ Reynolds, J. L., and Horton, B. T. Clinical Observations on the Use of Thephorin. A New Antihistamine Agent, *Proc Staff Meet, Mayo Clin* **22** 574-577, 1947.

¹⁶⁷ Kallos, P. Significance of "Histamine Antagonists" in the Treatment of Allergic Disease, *J A M A* **135** 315 (Oct 4) 1947.

¹⁶⁸ Pierce, J. D., and Mothersill, M. H. Treatment of Allergic Symptoms with a New Antihistamine Drug, *J Indiana M A* **40** 739-743, 1947.

¹⁶⁹ Ratner, B. Evaluation of Benadryl, Pyribenzamine, and Other So-Called Antihistaminic Drugs in Allergy, *J Pediat* **30** 583-602, 1947.

Waldbott¹⁷⁰ reviews critically the value of antihistaminic drugs in the treatment of allergies in general, and Archibald¹⁷¹ considers them in this light in a review of pediatric allergy

TREATMENT AND DRUGS OTHER THAN ANTIHISTAMINIC SUBSTANCES

Hartman¹⁷² has investigated a new synthetic antispasmodic drug beta-diethylaminoethyl-9,10-dihydroanthracene-9-carboxylate hydrochloride, designated as compound 887. Basing his conclusions on trials in 90 asthmatic patients, he considers it a safe and useful remedy. It has both an antispasmodic and a sedative effect, the latter limiting its value during the day but increasing it at night. Disappearance or marked diminution of rhonchi and relief of dyspnea, with shortening of the expiratory phase and increase in vital capacity, are objective criteria used in the evaluation of treatment. Subjective criteria include diminution of wheezing, shortness of breath and coughing, relief of orthopnea, and ability to rest at night. Eighty per cent of patients with moderately severe asthma were benefited. Doses of 0.2 Gm. every four hours are said to be sufficient in most cases. A few patients experienced side effects, including vertigo and dizziness.

Anrep and his associates¹⁷³ found that khellin ("visamin") in 200 to 300 mg. doses given intramuscularly produces complete and prolonged relief in 41 of 45 patients with severe asthma. Three patients required a second injection. Relief was obtained in some asthmatic persons in whom both aminophylline and epinephrine had failed. No deaths occurred in the series, and side effects are described as few and mild. Relief obtained with khellin is not so prompt as that obtained with epinephrine.

A long series of experiments on the pharmacology and toxicology of dihydroergotamine (DHE 45®) is reported by Orth and Ritchie¹⁷⁴. They found that while 6 patients with migraine claimed better results with this drug than with ergotamine tartrate, twice the dose was required for a comparable effect. Dihydroergotamine prevented the occurrence of cardiac arrhythmias due to anesthesia in dogs and mon-

170 Waldbott, G. L. The Antihistaminic Drugs, *J. A. M. A.* **135** 207-209 (Sept. 27) 1947.

171 Archibald, H. C. Allergy in Childhood. Long Range View. *Arch. Pediat.* **64** 192-198, 1947.

172 Hartman, M. M. Anti-Asthmatic Effects of a New Synthetic Antispasmodic. Beta-Diethylaminoethyl 9, 10-Dihydroanthracene-9-Carboxylate Hydrochloride, *Ann. Allergy* **5** 536-540, 1947.

173 Anrep, G. V., Baroum, G. S., Kenawy, M. R., and Misrahy, G. Therapeutic Uses of Khellin, *Lancet* **1** 557-558, 1947.

174 Orth, O. S., and Ritchie, G. A Pharmacological Evaluation of Dihydroergotamine Methanesulfonate (DHE 45). *J. Pharmacol. & Exper. Therap.* **90** 166-173 1947.

keys No oxytocic effects were noted, and the toxicity was found to be very low Orth and Ritchie feel that the absence of side effects is responsible for most of the favorable impressions made by the drug

Histamine azoprotein is discussed by Cohen and Friedman¹⁷⁵, Hebal, Cooke and Downing,²⁰ and Dundy, Zohn and Chobot¹⁷⁶ Cohen and Friedman found it useful in the treatment of urticaria and in certain cases of bronchial asthma but of no value in the prevention of hay fever when used alone They state that to obtain maximum immunity six months of treatment with adequate amounts is required Hebal, Cooke and Downing²⁰ found it of little value in the treatment of hay fever, and Dundy, Zohn and Chobot¹⁷⁶ report that it was generally ineffective in a series of 40 patients with various allergies Cohen and Friedman¹⁷⁵ mention large local reactions and considered them harmless and to be expected

Hansel¹⁹ reports on a series of 750 patients, 150 of them children from 2 to 14 years of age, who were treated for nasal allergy and bronchial asthma with nethaphyl® The report covers a seven year period The effectiveness of the drug in relief of symptoms is described as most satisfactory and untoward side effects as inconspicuous Doses and means of administration are discussed, and it is pointed out that repeated administration has not necessitated increases

Hartman¹⁷⁷ discusses the relation of sex hormones to allergy and their use in the treatment of allergic disorders He points out that allergies may begin or stop at either puberty or the menopause and that they may be related to the menstrual cycle An otherwise satisfactory regimen of elimination and desensitization may be ineffective at this time He feels that disturbed emotional balance is an important factor and that psychotherapy, together with antiallergic treatment, may be of value, until a hormone pattern can be established In the group of menopausal women the uninhibited overactivity of the pituitary gland may be controlled by estrogens or, if bleeding is present, by androgens, and good results are claimed in 84 per cent of this group Menstrual exacerbations of allergies were prevented in 83 per cent of cases by large, carefully timed premenstrual doses of estrogens with methyltestosterone during the postovulatory or premenstrual phase, or by desensitization to estradiol, if necessary, to minimize the estrogen excess The dangers of such treatment are discussed The conditions

175 Cohen, M B, and Friedman H J Histamine Azoprotein in the Treatment of Allergy, *J Allergy* **18** 7-12, 1947

176 Dundy, H D, Zohn, B, and Chobot, R Histamine Azoprotein Clinical Evaluation, *J Allergy* **18** 1-6, 1947

177 Hartman, M M The Use of Sex Hormones in Allergic Disorders, *Ann Allergy* **5** 467-477, 1947

treated included migraine urticaria, asthma and perennial allergic rhinitis

Goth and Holman¹⁷⁸ have found that large doses of a colloidal suspension of thorium dioxide (thorotrast®) protect dogs against anaphylactic shock, and they suggest that the liberation of histamine or heparin is prevented

Frank¹⁷⁹ has found a snake venom preparation, crotalin, effective in protecting sensitized guinea pigs from fatal anaphylaxis in 63.1 per cent of cases. It did not prevent fatal anaphylaxis when given as a single dose a day before the shocking dose of antigen.

Sympathectomy as an antiallergic measure is discussed by Coca¹⁸⁰

EXPERIMENTAL INVESTIGATION OF ALLERGY

Squire and Lee¹⁸¹ have demonstrated a reduction of approximately 43 per cent in the total number of white cells in the blood in patients sensitive to ragweed pollen on the addition of short ragweed antigen to heparinized blood in vitro. The polymorphonuclear leukocytes are said to be chiefly affected. In samples of blood heated to 50 C for one hour, the ragweed-sensitizing antibody was inactivated and lysis did not occur. No significant evidence of lysis appeared in the untreated blood of ragweed-sensitive patients after adequate treatment with ragweed antigen.

Randolph¹⁸² found that certain allergic persons exhibiting acute symptoms after trial ingestion of foods showed a decrease in eosinophils in the blood at the time of the reaction, followed by delayed eosinophilia as the symptoms subsided. Similar responses followed allergenic drugs in cases of known sensitivity. The reaction was best observed in acute responses of short duration and was more pronounced in some allergic persons than in others. It did not occur in normal or in allergic subjects on the administration of nonallergenic substances.

Rocha e Silva and his associates¹⁸³ have shown that the discharge of histamine and heparin by the isolated dog liver following administra-

178 Goth, H., and Holman, J. Effect of Thorotrast (Thorium Dioxide Preparation) on Anaphylactic Shock in Dog, *J Pharmacol & Exper Therap* **89** 379-381, 1947

179 Frank, D. E. Use of Crotalin in the Prevention of Anaphylactic Shock in Guinea Pigs, *Ann Allergy* **5** 156-159, 1947

180 Coca, A. F. Sympathectomy as an Antiallergic Measure, *Ann Allergy* **5** 95-101, 1947

181 Squire, T. L., and Lee, H. J. Lysis in Vitro of Sensitized Leukocytes by Ragweed Antigen, *J Allergy* **18** 156-163, 1947

182 Randolph, T. G. Blood Studies in Allergy. IV. Variations in Eosinophiles Following Test Feeding of Foods, *J Allergy* **18** 199-211, 1947

183 Rocha e Silva, M., Scroggie, A. E., Fidler, E., and Jaques, L. B. Liberation of Histamine and Heparin by Peptone from the Isolated Dog's Liver, *Proc Soc Exper Biol & Med* **64** 141-146, 1947

tion of peptone,, was markedly affected by the presence of blood in the perfusing fluid used. Only small amounts of histamine or heparin appeared in the perfusate when Tyrode's solution was used. These results are thought to suggest, but not prove, the participation of platelets, and perhaps leukocytes, in the mechanism of discharge of histamine and heparin from the liver.

Curry¹⁸⁴ reports on studies of the vital capacity of normal and allergic subjects given doses of 0.25 to 6 mg of methacholine chloride U S P (mecholyl chloride®) or 0.02 to 0.04 mg of histamine phosphate parenterally. Three of 10 normal subjects had a slight reduction in vital capacity. Of 11 patients with hay fever, all had a reduction in vital capacity, and in 7 of them it amounted to 5 per cent or more. With histamine phosphate the reduction was 5 per cent or more in only 2 of them. Of 27 persons with asthma or a history of asthma all but 1 had a decrease of 5 per cent or more in vital capacity when methacholine chloride was used, and 22, a similar reduction with histamine. The indications are that methacholine chloride is a little more potent than histamine in the respective doses employed.

Swineford and Houlihan¹⁸⁵ were not successful in demonstrating a simple method of titrating the blocking antibody in the serum of ragweed-sensitive patients with pollinosis who had been treated. They could not confirm the report of Cohen and Weller¹⁸⁶ that precipitins could be demonstrated in the serums of treated ragweed-sensitive patients, but not in the serums of untreated patients.

Samter and Becker¹⁸⁷ found ragweed reagins in the nasal secretions of 7 of 10 ragweed-sensitive patients, while nasal secretions from normal subjects gave negative results.

Ross¹⁸⁸ demonstrated that whereas a subcutaneous injection of more than 12.5 mg of purified egg albumin produced fatal anaphylaxis in guinea pigs, 27.5 mg was required when given in solutions with 10 per cent polyvinyl alcohol and 50 mg when given with protamine zinc in 10 per cent polyvinyl alcohol. He concludes that delayed absorption prevents the presence of a lethal dose at any one time.

184 Curry, J. J. Comparative Action of Acetyl-Beta-Methyl Choline and Histamine on the Respiratory Tract in Normals, Patients with Hay Fever, and Subjects with Bronchial Asthma, *J Clin Investigation* **26** 430-438, 1947.

185 Swineford, O., and Houlihan, R. Antibodies to Ragweed Extract: Demonstration by Collodion Particle Technique in Immune Rabbit Serum but not in Serum of Treated Patients, *J Allergy* **18** 190-195, 1947.

186 Cohen, M. B., and Weller, R. R. Precipitins in the Sera of Patients with Clinical Allergy: Preliminary Report, *J Allergy* **12** 242-243, 1941.

187 Samter, M., and Becker, E. L. Ragweed Reagins in Nasal Secretion, *Proc Soc Exper Biol & Med* **65** 140-141, 1947.

188 Ross, J. R. Delayed Absorption of Proteins in the Guinea Pig, *J Allergy* **18** 86-89, 1947.

MISCELLANEOUS ALLERGILS

Burden¹⁸⁹ discusses the problem of insulin allergy and its treatment. A case is reported in which treatment was successful with a modification of Urbach's method of skeptophylactic deallergization. An intradermal dose of 1/2,000 units of insulin was given three quarters of an hour before the required dose. This intradermal dose was determined on the basis of the production of a wheal about 15 mm in diameter.

Tropical eosinophilia and Loeffler's syndrome and the relations between these conditions are discussed by Font¹⁹⁰ who reports 2 cases, 1 of each disorder. Both patients were studied with the bronchoscope. The response of both the pulmonary lesion and the eosinophilia to treatment is thought to emphasize the relation of the condition to the offending organism, indicating a search for focal infection.

Alpher¹⁹¹ reports 2 cases of Loeffler's syndrome in 1 of which the condition was associated with hay fever while in the other recurrent features were presented.

Three cases of a condition diagnosed as allergic parotitis are reviewed by Waldbott and Shea¹⁹². The relation of swelling of the parotid gland to the onset of asthma is discussed. In 1 case the recurrent swelling preceded the asthma by many years, while in the other 2 cases the asthma preceded the swelling. Food sensitivities were shown to be the dominant cause of both the parotitis and the asthma. A brief review of the literature on allergic parotitis is presented. Another case of allergy of the salivary glands is reported by Johnston¹⁹³.

In a review of his experience in the Philippines, Friedberg¹⁹⁴ points out the number of patients in whom allergies (hay fever and asthma) developed for the first time and the number who had had mild allergies and had become disabled by them. He was impressed by the frequency with which dermatitis, external otitis and allergic rhinitis, sinusitis or bronchitis occurred in the same person. The humidity and the tropical flora are thought to be the responsible factors.

189 Burden, S. S. Treatment of Insulin Allergy with Report of a Case. *Ann Allergy* **5** 209-218, 1947.

190 Font, J. H. The Eosinophilic Lung, *Ann Otol, Rhin & Laryng* **56** 804-810, 1947.

191 Alpher, I. M. Loeffler's Syndrome. Report of Two Cases, One with Recurrent Features and One Associated with Hay Fever, *J Allergy* **18** 39-46, 1947.

192 Waldbott, G. L., and Shea, J. J. Allergic Parotitis, *J Allergy* **18** 51-54 1947.

193 Johnston, C. R. K. Allergy of Salivary Glands. Case, *Cleveland Clin Quart* **14** 55-57, 1947.

194 Friedberg, S. A. Otolaryngologic Experiences in the Philippines. *Arch Otolaryng* **45** 385-391 (April) 1947.

A symposium on allergy in the *American Journal of Medicine* included, among others, papers by Bohrod,¹⁹⁵ Cooke,¹⁹⁶ Kabat,¹⁹⁷ Rose¹⁹⁸ Feinberg,¹⁹⁹ Sherman²⁰⁰ and Rackemann²⁰¹

Of general reviews of allergy and allergic conditions may be mentioned those of Riley,²⁰² Piness,²⁰³ Dimsdale,²⁰⁴ Hartman²⁰⁵ (the newer drugs), Claybon²⁰⁶ (allergic headache), LePage²⁰⁷ (asthma in children) and Williams²⁰⁸ (relation of allergy to diseases of the eye, ear, nose and throat)

195 Bohrod, M G Classification of the Histologic Reactions in Allergic Diseases, *Am J Med* **3** 511-522, 1947

196 Cooke, R A The Immunology of Allergic Disease, *Am J Med* **3** 523-534, 1947

197 Kabat, E A Quantitative Immunochemical Aspects of Some Allergic Reactions, *Am J Med* **3** 535-544, 1947

198 Rose, B Role of Histamine in Anaphylaxis and Allergy, *Am J Med* **3** 545-559, 1947

199 Feinberg, S M The Antihistamine Drugs, *Am J Med* **3** 560-570, 1947

200 Sherman, W B Drug Allergy, *Am J Med* **3** 586-600, 1947

201 Rackemann, F M A Working Classification of Asthma, *Am J Med* **3** 601-606, 1947

202 Riley, B M B Present Position of Allergy, *M J Australia* **1** 270-272, 1947

203 Piness, G What's New in Allergy? *California Med* **67** 291-293, 1947

204 Dimsdale, L J Evaluation of Allergy in General Practice, *J Iowa M Soc* **37** 114-117, 1947

205 Hartman, M M Newer Drugs for Allergic Disorders and Their Place in Histamine Theory *California Med* **66** 242-248, 1947

206 Claybon, I H Allergic Headache, *Cincinnati J Med* **28** 23-39, 1947

207 LePage, C P Modern Treatment and Preventive Measures for Asthma in Children, *M Press* **217** 386-389, 1947

208 Williams, R I Allergy as Related to Ear, Nose and Throat, *Rocky Mountain M J* **44** 37-39, 1947

Abstracts from Current Literature

Ear

THE CLINICAL MANAGEMENT OF DEAFNESS KENNETH M. DAY, Pennsylvania
M J 52 698 (April) 1949

The article states that the earlier in childhood that pathologic changes of the middle ear, the eustachian tubes and the nasopharynx can be detected and corrected, the less trouble will be encountered in later life. It is essential that ventilation of the middle ears be maintained in infancy and childhood. Sclerotic mastoid processes usually result from improper treatment of chronic suppurative otitis media. Improper feeding in infancy is responsible for a major proportion of nonventilated middle ears. The infant should never be fed from a bottle while lying in a supine position, as swallowing may force fluids into the nasopharynx and a patent eustachian tube.

Secretion or fluid in the middle ear is a very common unrecognized condition in children. The cause may be swelling of the mucosa resulting from infection of the upper respiratory tract, entrance of foreign material in swallowing or vomiting, sudden changes of barometric pressure, congestive narrowing of the eustachian tubes, closing of the eustachian orifice by swollen lymphoid tissue, or adhesions around the mouth of the tube causing distortion. The symptoms are diminished hearing with a sense of stuffiness. The types are serous otitis and mucous otitis. The first is due to transudate blockage without inflammation. The drum shows a retracted drum membrane, a yellow cast and a fluid level, there is impairment of hearing for low tones.

The second, mucous otitis, is due to the exudation that occurs in inflammatory conditions. The drum membrane is not retracted but thickened and occasionally distended, it is opaque, shows no fluid level and is fixed on compression. There is impairment of the hearing of high tones, and the Rinne test is negative.

In local treatment inflation of the eustachian tubes usually relieves the serous type, under extreme circumstances, myringotomy may be performed, followed by inflation and suction. With the mucous type, myringotomy is necessary usually and may be followed by inflation and suction. Simple adenoidectomy is effective for the prevention of recurrences of serous otitis, for regeneration of adenoid tissue, irradiation is advised.

In dealing with the types of deafness due to nerve degeneration, it is important to differentiate in order to effect improvement. They are due to traumatic, toxic, vascular, allergic and central causes. Traumatic deafness may be due to continued and repeated exposure to high, intensive noises, the toxic type is due to infectious diseases, such as mumps, diphtheria, typhoid, influenza and syphilis and to drugs such as quinine, salicylates and streptomycin, nerve deafness due to vascular deficiency is found in arteriosclerosis, especially in that involving the anterior inferior cerebellar artery and its branches in cases of senile deafness, also in cases of hypotension and hypertension. Nerve deafness of the unilateral type may be allergic in origin or associated with true Meniere's disease.

Hearing aids are prescribed when there is a sufficient loss of hearing to prevent understanding of a normal conversational voice and when the hearing cannot be improved by medical or surgical means. Lip reading should also be advocated for children and young adults under these conditions. The hearing aids perform satis-

factorily for people with conduction or mixed types of deafness Bone receivers are limited to cases in which the patient has little or no nerve involvement or in which there is a discharge and the practical application would be inhibitive of an air receiver Hearing aids are not satisfactory for true nerve deafness when the loss is in the high frequencies

It is important that otologists be frank and honest with patients who have hearing losses, so that these patients will have faith in them and try to comprehend their own condition

LANDIS, Reading, Pa

INFLUENCE OF SULFONAMIDE DRUGS ON LABYRINTHITIS AND ON INDICATIONS FOR OPERATIVE INTERVENTIONS IN THE INNER EAR VLADIMIR HLAVÁČEK, *Acta oto-laryng* **35** 258 (May-June) 1947

The observations of Hlavacek indicate that in cases of labyrinthitis complicating acute otitis it is possible by employing intensive treatment with sulfonamide drugs to defer operation on the inner ear, even though the increase of cells in the spinal fluid is such that in the days before the use of sulfonamide drugs labyrinthectomy would have been indicated

The author observed 7 cases of acute labyrinthitis complicating acute otitis media In all these cases intensive treatment with sulfonamide drugs was instituted, with only paracentesis or antrotomy as an operative procedure Although an increase in the cells of the spinal fluid was present, the operation on the inner ear was postponed, even when as many as 208 cells were encountered In 6 of these cases a cure was achieved without an operation on the labyrinth, and in 1 case a labyrinthectomy was performed In all cases recovery followed

In 5 cases of labyrinthitis occurring during the course of chronic otitis media the same sulfonamide treatment was instituted at the beginning of the meningitis as in cases in which an abolition of the function of the inner ear was present In all cases an increase in the number of cells in the spinal fluid occurred in spite of intensive sulfonamide treatment, so that labyrinthectomy was necessary Therefore, the sulfonamide therapy did not influence the course of otitis interna occurring in the course of chronic otitis media

GROVE, Milwaukee

STUDIES ON THE STABILITY OF MAN L B W JONGHEES and J J GROEN, *Acta oto-laryng* **35** 327 (July 31) 1947

In this article an interesting mechanical and physical study of the stability of man is represented The authors test the ability of the human organism to resist sudden changes in position The testing is done with an apparatus in which a small car riding on rails can be given any desired acceleration After the acceleration it carries with it a constant speed until it is braked, the accelerations are accurately measured

The average results in a series of 50 volunteers were as follows The authors found that acceleration in a forward direction can be up to 76.75 cm per second per second, in a backward direction up to 48 cm per second per second and laterally up to 33 cm per second per second when the subjects stand erect with the eyes closed and the feet together The authors have developed an index to express steadfastness This is expressed by the proportion between the acceleration and the normal figure for the three principal directions put together

The stability of the human body is determined by the labyrinth With normal labyrinthine response the stability within the limits of the muscular strength of the person corresponds somewhat to that of a statue of corresponding shape

ROBERT LEWY, Chicago

Larynx

NEW TECHNIC FOR THE TREATMENT OF THE DILATOR PARALYSIS GEORGES PERELLO, *Rev de laryng* 70 80 (Jan-Feb) 1949

The surgical procedure recommended is as follows

1 A horizontal incision of skin and fascia is made over the median part of an ala thyroid of the cartilage, from the sternocleidomastoid muscle to a point 1 cm on the opposite side

2 The omohyoid muscle is retracted, and the sternohyoid muscle is incised and retracted. The thyroid gland is retracted down if necessary

3 The sternothyroid muscle is sectioned and elevated, covering the thyroid cartilage (an ala). The muscle is then resected 0.5 cm at its upper end

4 A horizontal longitudinal window is opened in the thyroid cartilage with a sharp scalpel or a circular saw, its internal perichondrium is removed and the thyroarytenoid muscle is thus visualized. Its inner bundle forms the true vocal cord

5 The latter muscle is then removed in a depth of 2 mm, and its inner bundle is sutured to the upper end of the sternothyroid muscle with no. 2 catgut

6 The sternohyoid muscle is sutured, and the wound is closed by successive planes

The author insists that, in order to avoid entrance into the pharynx, the fenestra of the thyroid ala should be situated in the latter's anterior inferior quadrant

The sternothyroid muscle, contracting itself during inspiration, will carry the vocal cord outside the fenestra, and the shortening of the muscle surgically as mentioned, will help markedly the abduction of the cord. This operation appears to the author to be more rapid and simpler than most of the procedures recommended and does not open the pharynx or the larynx. The voice is conserved

HERSON, Chicago

Nose

TREATMENT OF CHRONIC NASAL DIPHTHERIA CARRIERS. REPORT OF CASE JOSEPH X. MEDWICK and OLAV E. HALLBERG *Ann Otol, Rhin & Laryng* 57 135 (March) 1948

The finding of a fetid, irritating unilateral or bilateral discharge from the nose causing excoriation and swelling of the alae nasi and upper lip should suggest the presence of diphtheria organisms. Since all strains of the diphtheria organism are not pathogenic, it is necessary to test the virulence of the culture obtained. There is considerable evidence that a patient may acquire a virulent strain and carry it in the nose indefinitely without clinical evidence of toxic effects, a condition ascribed to autoimmunization. The virulence of the organisms in the nose may become attenuated so that they are harmless, but at some future time they may again become virulent, owing either to local trauma or to infection with other bacterial forms. Treatment of nasal diphtheria carriers with antiseptic nose and throat sprays and by painting the throat with solutions of iodine or formaldehyde has not been satisfactory. Diphtheria antitoxins have given little success, probably because they exert no direct action on the organisms themselves. Tonsillectomy and adenoidectomy combined with use of sprays of an antiseptic solution or chemotherapeutic agents frequently have proved useful. Roentgen radiation, sulfonamide drugs and penicillin are usually effective in the treatment of chronic nasal diphtheria carriers. However, the presence of chronic sinusitis in a nasal diphtheria carrier is an indication for surgical treatment combined with chemotherapy. Despite the infrequency of the occurrence of diphtheria organisms among

nonimmunized patients who have a chronic nasal infection, material from the nose should be cultured for these organisms. Cured carriers should be checked periodically, especially after severe infections of the upper respiratory tract.

MILLER, Philadelphia

THE ROLE OF THE RHINOLOGIST IN RHINOPLASTY. SAMUEL SALINGER, *Laryngoscope* **58** 720 (July) 1948

Salinger presents convincing reasons that rhinoplasty should be included in the field of rhinology. Not only is the rhinologist the logical person to perform such work, but also he is being gradually deprived of much of the work he formerly did: sinus and mastoid operations, bronchoscopy and even tonsillectomies. To do competent rhinoplasty, however, is not easy; the candidate must be able and adept and his training thorough.

HITSCHLER, Philadelphia

RATIONALE FOR REMOVAL OF EVERY VESTIGE OF DEVIATED NASAL SEPTUM. E. MARKEY PULLEN, *Laryngoscope* **58** 1055 (Sept.) 1948

Pullen presents arguments to show that a total removal of deviated septal bone and cartilage is desirable. It has been thought that a rim of cartilage and bone should be left as a support. This is not true. The septum itself under static conditions does not support the nasal ridge or tip. Deformities occurring after a submucous resection are not due to lack of support but, rather, to cicatricial contractions of the area of operation. Operative procedures to prevent these contractions are presented and anatomic, physiologic, mechanical and clinical considerations discussed.

HITSCHLER, Philadelphia

THE REMOVAL OF SECRETIONS FROM THE NASAL ANTRUM. THE PART PLAYED BY PRESSURE WHEN IRRIGATING THE NASAL PASSAGE WITH WARM SALINE SOLUTION, A PHYSICAL HYPOTHESIS. J. J. CANTOR, *Laryngoscope* **57** 1307 (Dec.) 1948

Cantor attempts to prove theoretically how secretions are removed from a sinus by irrigation of the nasal cavity. He shows that their removal is due to the warming and hence expansion of the air in the sinus, which forces the secretions out, rather than by the sucking effect of the fluid passing by the sinus ostium. If the air is allowed to cool, repetition of the procedure will remove further secretions. He suggests that the procedure be called "the interrupted replacement method."

HITSCHLER, Philadelphia

Miscellaneous

TWENTY-FIVE YEARS OF CLEFT PALATE PROSTHESIS. CLOYD S. HARKINS and HERBERT KOEPP BAHR, *J. Speech & Hearing Disorders* **13** 23 (March) 1948

Great advances have been made in the development of speech aids constructed for functional improvement in cases of cleft palate. The fixed bulb type of instrument is now generally conceded to be the most satisfactory in most cases. The size and shape of the bulb and the palatal extension are highly individualistic. A surgical redivision sometimes needs to be done for proper positioning of the bulb appliance in the pharynx. A number of clinics have shown that with the combined services of the pediatrician, surgeon, prosthodontist, orthodontist, general dentist, speech correctionist and psychologist-educator, the total needs of the child can best be evaluated and served. The examinations should be made concurrently with

opportunity for extensive interconsultation. Time has shown that the use of certain materials and technics can keep the cost of cleft palate prosthesis well within the economic limits which enable children and adults who require it to be provided with the apparatus

PALMER, Wichita, Kan

STUDIES IN CLINICAL TECHNIQUES III MANDIBULAR FACET SLIP IN CEREBRAL PALSY MARTIN F PALMER, J Speech & Hearing Disorders **13** 44 (March) 1948

In this article, attention is called to a serious deformity existing in cases of cerebral palsy, particularly tension athetosis and spastic paralysis, in which the mandibular condyle slips from the hinged joint, resulting in a cumbersome, slow and unprecise mode of speech. Correction of the speech disorders found in cases of cerebral palsy cannot be adequate without reduction of this abnormality. Technics are outlined as used by the Institute of Logopedics for the reduction of slipping of the mandibular facet during the acts of chewing, sucking, swallowing and speech.

PALMER, Wichita, Kan

SPEECH SURVEY METHODS IN PUBLIC SCHOOLS VANETTA R SUYDAM, J Speech & Hearing Disorders **13** 51 (March) 1948

The author enumerates four principal methods of locating children in need of speech training now used by speech clinicians. The first is the referral method, in which classroom teachers, principals, parents and others refer to the correctionist those children needing remedial speech work, the second is the speech survey, the third is a combination of the referral and the survey method, and the fourth is voluntary enrolment by the students themselves. The speech survey generally consists of a questionnaire, a personal interview or a combination of the two. A study of survey methods used in this country shows that a child needs to be surveyed only once. Teachers should notify correctionists of children who need retesting. If each child is given a sweep test, after which doubtful subjects are retested, the results are more reliable. Methods used in speech surveys should be adapted to the needs of the individual clinician, the children tested, the community and the situation. The speech survey is an essential part of the speech correctionist's work.

PALMER, Wichita, Kan

CLINICAL MANIFESTATIONS OF HODGKIN'S DISEASE JOHN H TALBOTT, New York State J Med **47** 1883 (Sept 1) 1947

This report grew out of a study of 6 patients with Hodgkin's disease who were seen at the Buffalo General Hospital or in the clinics of the University of Buffalo School of Medicine. Of interest to the ear, nose and throat specialist is the fact that in each instance the cervical nodes were involved. The general symptoms and signs were generalized lymphadenopathy, roentgenographic evidence of hilar and mediastinal hypertrophy, cutaneous manifestations, fever, weakness, malaise, loss of weight and cervical adenopathy. Radiation therapy was given in every instance, and for some nitrogen mustard (methyl-tris-[2-chloroethyl] amine hydrochloride) was also used, but with the observation that it was chiefly of negative value.

Early diagnosis is not made in many cases. Since biopsy is the chief factor in diagnosis of this disease, it is urged that in any case in which observable enlargement of lymph nodes persists or continues, biopsy of the node be done. Furthermore, a clinical diagnosis of Hodgkin's disease should not be made without biopsy.

The cervical or axillary nodes are to be preferred to the inguinal nodes for biopsy. Since radiation may alter the pathologic appearance of lymph nodes, its use should be withheld in most instances until after biopsy.

VOORHEES, New York

DIAGNOSIS OF BRAIN TUMORS IN CHILDREN TRACY J. PUTNAM, *Am J Dis Child* **75** 721 (May) 1948

Tumors of the brain are rarer in children than in adults but are among the commonest tumors in the very young. They are expanding lesions, so that headaches caused by the pressure are early and should arouse suspicion, since children rarely have headaches from common causes. Vomiting is not necessarily projectile, and a full meal may be eaten with relish after an attack. Bulging of the fontanels and separation of sutures are common cranial findings. Choked disk comes later than in adults, but paralysis of the sixth nerve occurs from expansion of the nerve as it passes through the incisura. A slow, relentless progression of symptoms is common. The head is carried to one side, and attempts to move it are met with great pain and cervical spasm. Special diagnostic methods are electroencephalography, lumbar puncture, and encephalography and ventriculography combined. Stereoscopic roentgen ray studies are valuable. In the majority of cases the tumor is in the posterior fossa with symptoms familiar to the otolaryngologist. Cushing was among the first in the United States to describe "Intracranial Tumors of Preadolescence" (*Am J Dis Child* **33** 551 [April] 1927). The literature on this subject seems to be limited in amount. Very few of such brain tumors are operable, and the prognosis is unfavorable.

VOORHEES, New York

VITAMINS IN OTOLARYNGOLOGY P. E. HERSON and J. CHALMAGNE, *Acta oto-rhino-laryng belg* **2** 103, 1948

The writers review the cause and circumstances of appearance of vitamin deficiencies, as well as the action of vitamins and state that their use in otolaryngology is as yet on an empiric basis. Successful vitamin therapy has been established for only a few conditions: (1) ascorbic acid and vitamin K for hemorrhagic states, (2) pyridoxine (vitamin B₆) for auditory neuritis, vertigo and Meniere's disease and (3) nicotinic acid amide (P-P factor), vitamin M (yeast and liver extract essential for nutritional and hematopoietic equilibrium in monkeys) and vitamin B complex for pellagra and oral and pharyngeal lesions.

HERSON, Chicago

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SURGICAL TREATMENT OF MALIGNANT TUMORS OF THE INFERIOR ALVEOLUS AND MANDIBLE

JOHN J. CONLEY, M.D.

AND

GEORGE T. PACK, M.D.
NEW YORK

THE TREATMENT of choice for primary malignant tumors of the inferior alveolus and mandible is radical resection of the bone and surrounding tissues. The approach and the extent of the surgical procedure are governed by the type, size and position of the tumor. Irradiation is often an invaluable preoperative adjunct.

Tumors of the mandible may be primary or secondary. The primary type arising in the alveolus or mandible comprises the majority of cases. The secondary type may be the result of metastasis from malignant tumors of the prostate gland, breast, kidney, thyroid gland, lung or gastrointestinal tract, or it may be the result of direct extension from a malignant tumor of the lip, tongue, cheek, floor of the mouth or salivary glands. The discussion in this article will be limited solely to primary neoplasms.

Classification of Malignant Tumors of the Lower Jaw

- A Carcinoma
 - 1 Epidermoid (from gingiva and cheek)
 - 2 Basal cell (from overlying skin)
 - 3 Adenocarcinoma (salivary gland tumors)
- B Tumor from bone-forming tissues
 - 1 Osteogenic sarcoma
 - 2 Chondrosarcoma
 - 3 Malignant giant cell
- C Tumor from bone marrow
 - 1 Ewing's tumor
 - 2 Myeloma
- D Tumor from neighboring somatic tissues
 - 1 Fibrosarcoma
 - 2 Liposarcoma
 - 3 Malignant melanoma
 - 4 Lymphosarcoma
 - 5 Adamantinoma

E Tumor from blood vessels and nerves in bone

- 1 Angiosarcoma
- 2 Angioendothelioma
- 3 Neurosarcoma

DIAGNOSIS OF MALIGNANT TUMORS OF THE JAW

The diagnosis of malignant tumors of the jaw is accomplished by (1) clinical examination, (2) stereoscopic roentgen studies of the mandible and (3) biopsy. Malignant growths of the lower jaw are not uncommon. They comprise 20 per cent of all of the cancers of the mouth. They may originate from the soft tissues of the alveolus, the periosteum, the osteogenic substance of the mandible or the nonodontogenic and nonosteogenic substance in the mandible. Although malignant tumors of the alveolus and mandible are situated in readily accessible positions for early diagnosis, most of them are well advanced by the time they are identified and receiving treatment. This is sometimes due to fear or lack of interest on the part of the patient, but very frequently the medical and dental professions are also remiss in making an early and correct diagnosis. Failure to investigate an indefinite type of toothache or pain in the jaw, misinterpretation of inflammatory hyperplasia and ulceration, inattention to precancerous lesions and prolonged observation of hard and soft tumors are some of the reasons for the loss of valuable time in the management of these cases.

In a general way, the carcinomas tend to appear on the alveolus of the horizontal ramus. As a rule they appear after the fourth decade of life. Males are affected more frequently than females. This cancer is more prone to occur in ill kept mouths and as a result of chronic irritation from poorly fitted prostheses. In their early stages carcinomas of the alveolus are usually painless and slow growing, with a tendency toward ulceration and infiltration. After invasion of the mandible, severe pain may be experienced along the distribution of the inferior dental nerve. Occasionally cancer of the jaw may be superficial and fungating in character.

Sarcomas of the mandible may grow very rapidly, have less tendency to ulcerate in the early stages and often cause a dull aching type of pain. They frequently metastasize early to the lungs and other distant organs. All these tumors are firm to palpation except angiosarcoma and lymphosarcoma. Sarcomas may originate inside the mandible, destroy the substance of the bone and perforate into the surrounding soft tissue, or they may originate in the soft tissues and destroy the mandible by invasion. An indefinite aching type of pain in the jaw or teeth is an early symptom. Early and extensive destruction of bone is characteristic. Often the teeth become loose and fall out. There may be a history of trauma preceding the appearance of the tumor in rare

special instances, but a single injury cannot be said to be the causative factor in the origin of these neoplasms

Stereoscopic examination of the mandible assists in determining the variety and extent of bone destruction. In early malignant tumors of the alveolus, periosteum and bone there is usually no destruction of bone evident on roentgenographic study. In rare instances there may be enough infiltration of bone to cause pain and structural weakness without demonstrable evidence of alteration in density of the bone. However, in the more advanced malignant growths changes in bone are usually obvious. These are manifested by osteolytic and osteogenic alterations in any or all portions of the bone. Invading cancer causes marked reduction in density of the bone without accompanying new bone formation. The infiltration is destructive in character. In contrast, osteogenic sarcoma progresses from an interval position toward the cortex and soft tissues. Roentgenographically there is evidence of osteolytic and osteogenic activity. Fibrosarcoma presents a roughened, eaten-out outline. Chondrosarcoma shows blotchy areas of calcification and ossification associated with a thick shell. Ewing's tumor presents layered, irregular shadows and destruction of bone. Myeloma is characterized by areas of reduced density with essentially normal-appearing adjacent bone. Adamantinoma destroys normal bone and replaces it with multiple cystic bone spaces surrounded with a bony shell. Typical angiosarcoma reveals slight cortical or cancellous erosion and usually a small oval tumor on the periphery of the bone. Sarcoma of the nerves and soft parts about bone may cause pressure erosion.

Biopsy should be done in all cases. In new growths originating on the alveolus, periosteum and external surface of the mandible, biopsy material is readily available. However, it may be necessary in diagnosing a destructive lesion of the medullary cavity of the mandible to open the cortex and secure a direct biopsy at operation. An aspiration biopsy, with use of a 17 gage needle attached to a Record syringe, is often successful in removing sufficient tissue to permit a correct microscopic diagnosis. Usually in all advanced cases of malignant tumors of the mandible there is adequate tissue available for biopsy.

SURGICAL APPROACH

A classification as to the type and extensiveness of involvement of the tissues in the mouth and neck assists in planning the surgical approach.

- Class 1 Early, low grade cancer limited to the alveolus
- Class 2 Early, low grade cancer limited to the alveolus and upper portion of the mandible
- Class 3 Cancer of the jaw which has extended beyond the alveolus or deeply into bone

- Class 4 Cancer of the jaw which has extended to the floor of the mouth, cheek and tongue
- Class 5 Cancer of the jaw with any degree of local involvement plus metastasis to the upper or deep part of the neck

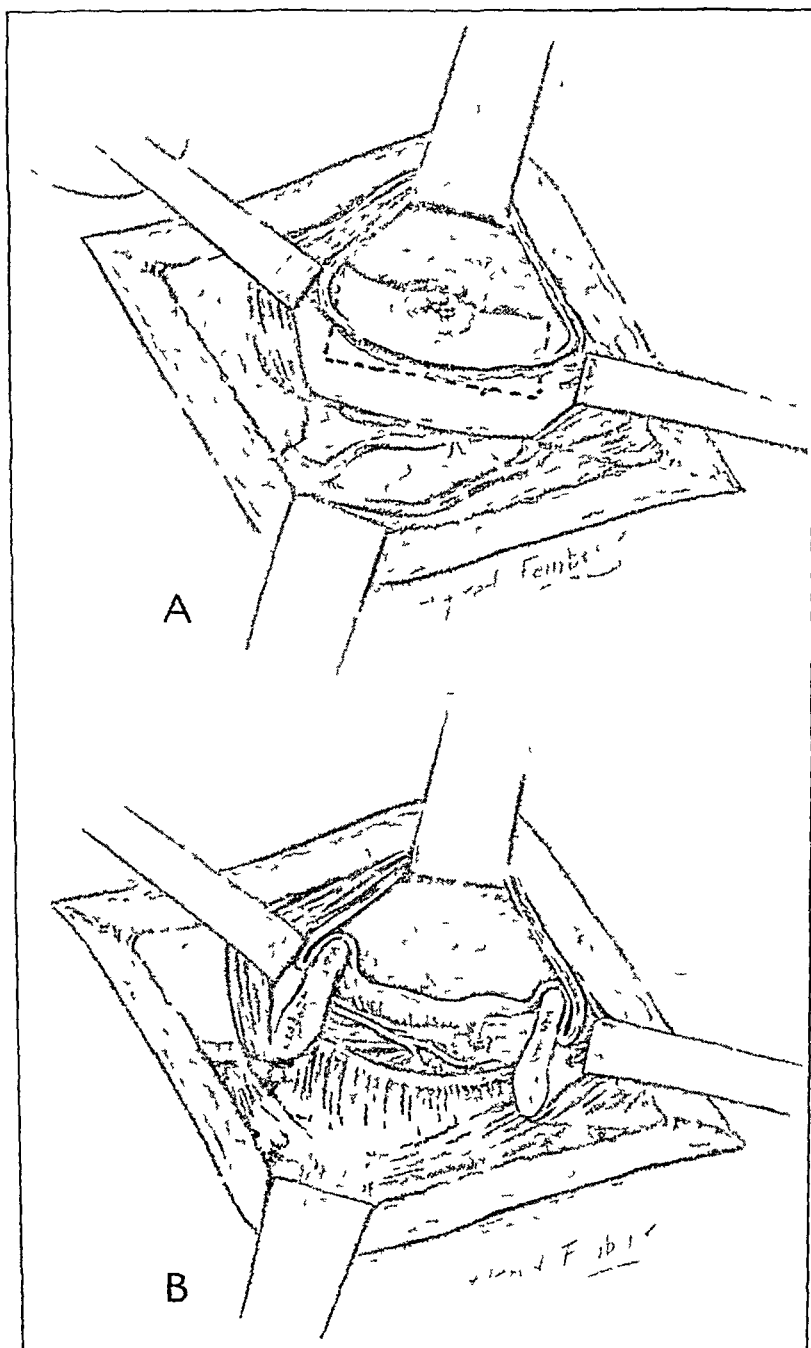


Fig 1—*A*, segmental resection of the horizontal ramus for early low grade, limited carcinoma *B*, cut ends of the mandible, the tongue, the cut border of the mylohyoid muscle and ligated vessels In this instance the section of mandible has been removed along with the contents of the submaxillary space and tip of parotid gland

It is imperative in the surgical treatment of neoplasms of the lower jaw that the tumorous growth be widely excised. This resolves itself basically into four types of operations, each with variations and modifications. These technics include the following procedures:

I Segmental resection of a portion of the ramus with preservation of the inferior rim of the mandible for early, limited cancer of the alveolus. This procedure is not generally associated with the combined mouth and neck dissection (fig 1A).

II Sectional resection of horizontal ramus with preservation of the ascending ramus and usually one horizontal ramus for early cancer of the mandible or alveolus. This procedure may or may not be associated with a suprahyoid or radical lateral neck dissection (fig 1B).

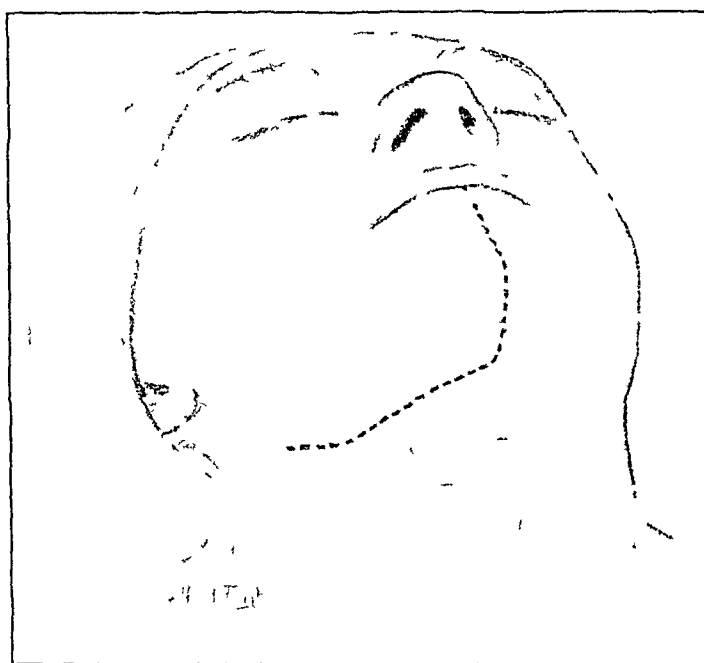


Fig 2—Lower lip flap utilized in approach to more extensive cancer

III Hemiresection of the mandible with preservation of one horizontal ramus and one ascending ramus for advanced cancer of the mandible with or without extension to the floor of the mouth, tongue and neck. This procedure is usually associated with the combined suprahyoid or radical neck dissection (fig 2).

IV Resection of the mandible including both horizontal ramus with or without the ascending ramus for advanced cancer of the mandible usually with extension to the floor of the mouth, tongue and neck. This procedure is usually associated with the combined resection of the jaw, tongue, floor of mouth and lateral portions of the neck (fig 3).

All associated soft tissues should be excised with the bone en masse. When the tumor transgresses the boundaries of the jaw, the involved adjacent soft tissues may include a portion of the tongue, floor of the

mouth and buccal mucosa. A further extension of the cancer may appear as metastasis in the suprahyoid or deep lymph nodes of the neck. The attack on cancer of the jaw with metastasis in the neck includes a combined radical resection of the primary cancer which may include tongue, floor of mouth, mandible and cheek, with a radical dissection of the entire neck in continuity. This applies, regardless of the degree of local extension, when any metastatic deposits are discovered in the submaxillary or submental spaces or the deep carotid region.

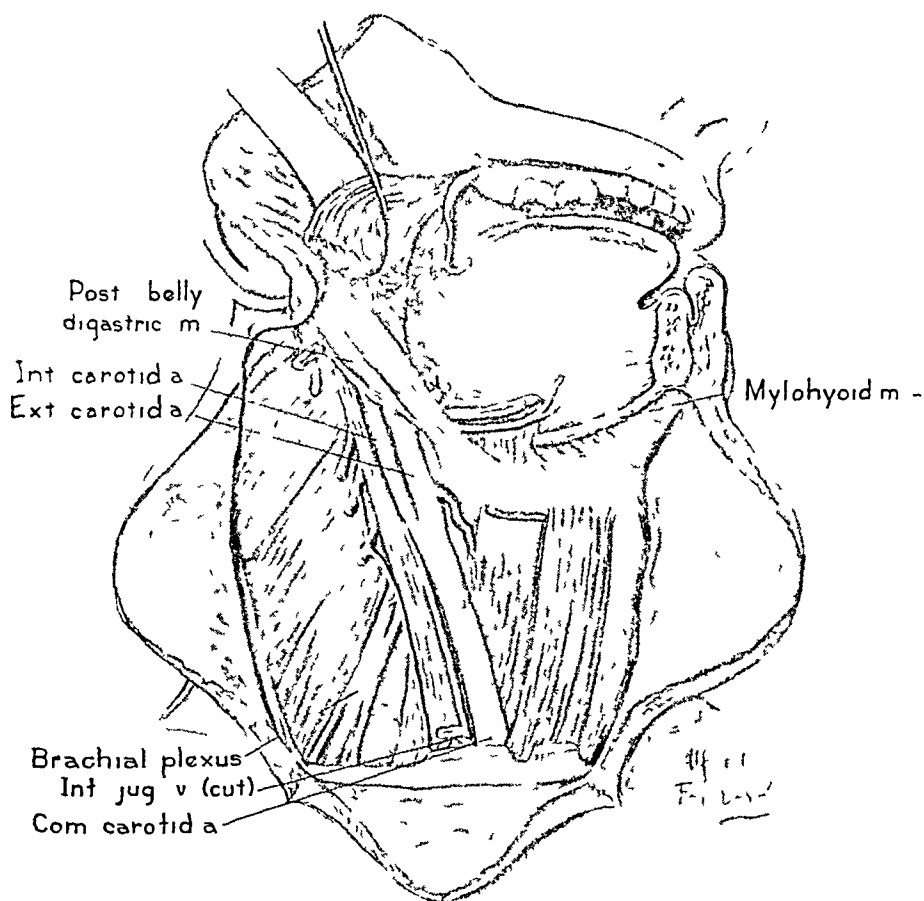


Fig 3—Half of the mandible, tongue, floor of the mouth and entire lateral contents of the neck have been removed in continuity. The approach is through the combined incisions of the lateral portion of the neck and lower lip.

In the approach to this surgical problem, certain prophylactic and precautionary measures have been found essential. They reduce the mortality and morbidity and assist in the cure.

Routine ligation of one or both external carotid arteries aids in hemostasis and facilitates the operation. However, it is preferred not to perform an arterial ligation if a bone graft is done in order that the recipient site may retain its blood supply.

Endotracheal or thiopental sodium (pentothal sodium®) anesthesia is preferred

The pharynx should be snugly packed with gauze packing to prevent the aspiration of blood

Prophylactic tracheostomy is a safeguard against asphyxiation and should receive serious consideration for all patients in whom the continuity of the mandible is disturbed and the procedure has included manipulation of the floor of the mouth and the neck. When endotracheal anesthesia is employed, the tracheostomy may be done at the conclusion of the operation, when thiopental anesthesia is used, it should be done at the beginning of the operation. Decannulization may be carried out in three or four days

Installation of an endonasal feeding tube permits maintenance of a normal dietary intake and electrolyte balance

Oral hygiene should be diligently applied before any radical operation in the mouth is attempted. This is particularly true when grafting is to be done. It includes treatment to infected gums, cleaning and filling of carious teeth and extractions of abscessed teeth

Energetic use of the antibiotics and chemotherapeutic agents is most helpful in preventing and controlling infection

Adequate drainage of the wound is necessary

A large supportive dressing assists in healing

Intelligent medical supervision of all medical aspects of the case is often the difference between success and failure

SURGICAL TECHNIQS

I Segmental Resection of the Alveolus and Mandible for Early Limited Carcinoma of the Inferior Alveolus Without Apparent Involvement of Bone and Without Metastasis to the Neck (fig 1 A)—This neoplasm is treated by a wide intraoral or submandibular excision of the alveolus and underlying bone without fracturing the continuity of the mandible. The buccal and lingual mucous membrane and alveolus are freed 2 cm or more beyond the gross limits of the tumor on all sides. Gigli saws are threaded over the bone and through two metal directors in soft tissue puncture wounds beneath the mandible when the intraoral route is used. The oral part of the mandible is partially transected proximally and distally to the tumor with the Gigli saw. This segment of bone, periosteum, alveolus and neoplasm is then separated from the lower rim of mandible with a sharp osteotome and mallet. If the segment of bone is anterior, between the mental foramens, it may be removed with the aid of the electric saw. The raw surfaces of the mandible are then covered with appropriate intraoral mucous membrane flaps. Neck dissection is not indicated

If it has been necessary to leave only a thin rim of the mandible at the site of the excision and there is doubt about its strength and functional ability, intermaxillary wiring should be maintained for six weeks. If the regenerative callus is inadequate, implantation of a bone graft will correct the weakness.

This surgical technic has limited applicability in the surgical treatment of cancer because in the majority of patients presenting themselves for treatment the disease has advanced beyond the stage that intraoral segmental resection will control it.

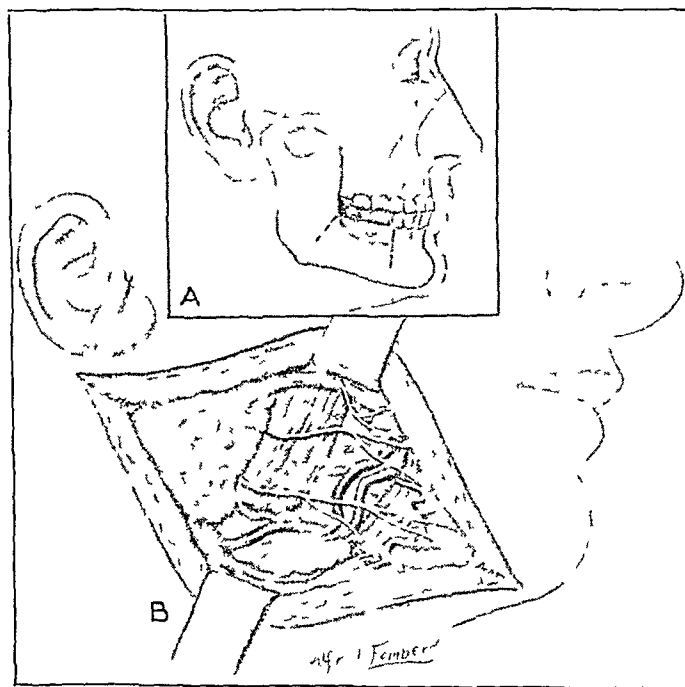


Fig 4—Submandibular approach to the horizontal ramus

II Sectional Resection for Limited Carcinoma Involving the Mandible or Alveolus Without Metastasis to the Neck, Corrected with Immediate Iliac Bone Graft—When the alveolus and mandible are involved by an early low grade cancer and there is no evidence of metastasis to the neck, a sectional resection of the bone and alveolus may be performed without neck dissection. This procedure may be followed by an immediate free bone graft in the reconstruction of the mandibular arch. The cancer may be approached intraorally or externally. The external approach may be submandibular or by the creation of a large lower lip flap. When immediate bone grafting is desired, the submandibular approach is preferred. When there is any question of adequate exposure of the tumor the creation of the lower lip flap is essential.

In the submandibular approach, when bone grafting is desired the soft tissues about the jaw are exposed through a 3 to 4 inch (7.5 to 10 cm) incision, 1 inch (2.5 cm) below and parallel to the horizontal ramus. The section of the mandible, with the associated alveolus and periosteum, is freed with the aid of the Gigli saw and double action bone-cutting forceps after appropriate, wide intraoral circumvention of the tumor (fig 1 A, 4 and 5)

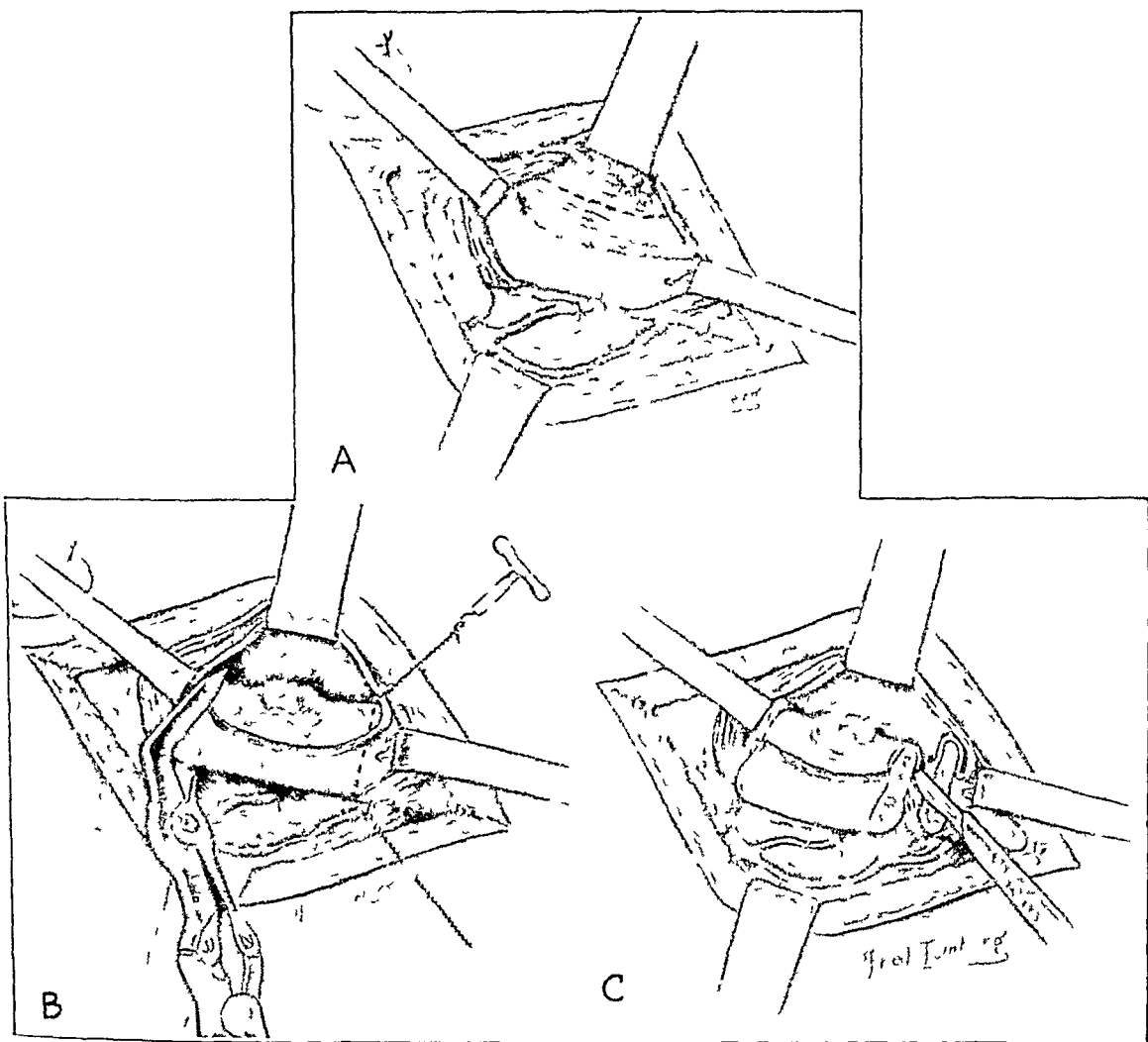


Fig 5—A, exposure of the horizontal ramus from the mental foramen to the angle with the buccinator muscle still intact B, sectional resection of the mandible. The buccinator muscle is cut. The tongue is visible above and the submaxillary gland below C, freeing the section of the mandible from the floor of the mouth

An immediate osteoperiosteal graft from the inner aspect of the iliac crest is cut and modeled to duplicate the size and shape of the section of mandible removed.

The methods of fixation of this graft are governed by the number and position of teeth remaining in the mouth and also the position of

the bone graft with respect to the mandibular arch. When a satisfactory number of dental components are available, intermaxillary wiring is the treatment of choice. The major part of the application of these wires may be carried out the day before the operation in anticipation of complete immobility, which is accomplished by the fixation in occlusion of the intermaxillary wires twenty-four hours after the operation. The bone graft in this instance should be wired to the adjoining mandibular surfaces to maintain continuity.

If there are no teeth in the posterior mandibular segment and it is still desired to use the intermaxillary wiring technic, a plaster head cap may be applied and the posterior fragment immobilized by placing a wire through a small drill hole at the angle of the mandible and fixing that wire to a stabilization pole incorporated in the posterior part of

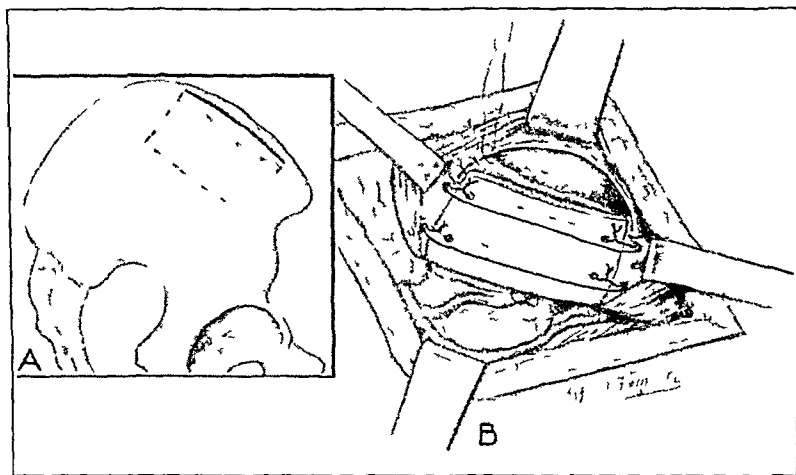


Fig 6—*A*, donor site on the iliac crest. *B*, implantation and internal fixation of the free osteoperiosteal bone graft by wiring technic. The submaxillary gland has not been removed.

the head cap. The teeth that are available may be wired together as previously described.

If there are no teeth in either segment, circumferential wiring or the Stador or Roger Anderson apparatus may be used or the graft may be immobilized by internal fixation. The external splints do not work so well practically as might be desired. Frequently the screws become loose, and infection occurs about them. Also, it is difficult to adapt them to the situation in the mandible which has developed as a result of the loss of a large section of the horizontal ramus.

Internal fixation of the graft has proved very satisfactory and may be accomplished by the use of screws, wires or plates. Fixation by wires consists in drilling two holes in each segment of the mandible and at each end of the bone graft. Tantalum or stainless steel wire may then be used to secure each end of the bone graft to the adjacent cut surface

of the mandible, and this may be reenforced by through and through wires supporting the bone graft medially and laterally (fig 6)

Another technic consists in the use of an internal metal splint. This is modeled from a bone plate to fit the ascending ramus, the free osteoperiosteal bone graft and the cut end of the horizontal ramus. The bone graft is anchored to the free ends of the remaining sections of mandible with braided tantalum wire. The continuity of this arch is then fixed by the application of the modeled metal bone splint, which is held in position with screws in the respective sections of bone (fig 7)

It is important to cover the bone graft securely above with mucous membrane flaps in the mouth in order to eliminate subsequent contami-

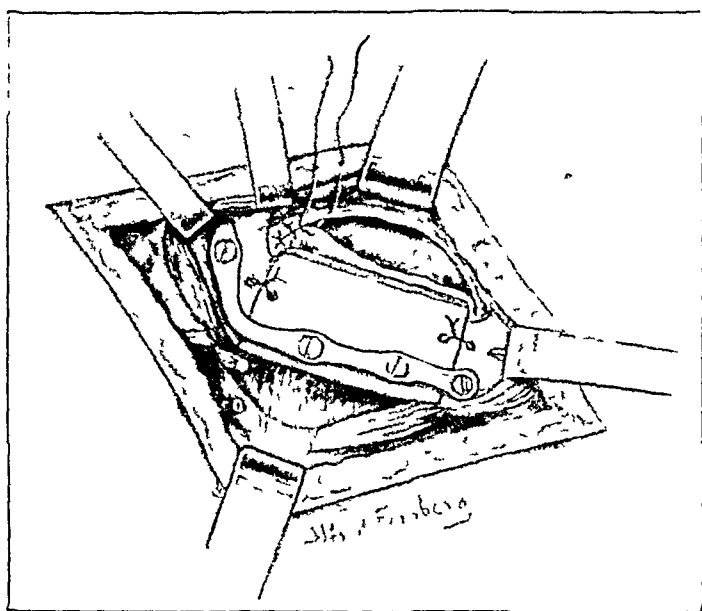


Fig 7—Implantation and internal fixation of a free osteoperiosteal iliac bone graft by use of modeled bone plate and screws. The contents of the submaxillary space and the tip of the parotid gland have been excised.

nation and infection. Soft tissues are then adapted about the graft, a small rubber drain is placed in the inferior pole, and a supportive dressing is applied. The patient is fed through a Levin tube for two to four weeks and later given a liquid diet by mouth. The function of the mandible is gradually resumed over a period of another two months.

Variations on this technic include utilization of the rib or tibia or remainder of the mandible as donor sites and fixation with plates, screws and external appliances.

If it has been decided not to do a bone graft at this time, the continuity and position of the jaw may be maintained by internal or external splints or intermaxillary wiring. This mitigates contracture and distortion of the remaining fragments.

A discussion of the treatment of carcinoma of the mandible, at this point, must include the technic of combined suprahyoid or radical neck dissection and excision of the floor of the mouth and part of the tongue. When the carcinoma has extended slightly beyond the alveolus or deeply into the bone, yet without clinical evidence of metastasis in the neck, a suprahyoid dissection should be performed simultaneously with a sectional removal of the bone.

The technic for combined suprahyoid dissection and resection of the jaw may be performed through an extended submaxillary or submaxillary and lower lip type of incision (fig 2). When the primary carcinoma has extended slightly beyond the alveolus and has definitely involved bone without clinical evidence of metastasis to the neck the approach is limited to a crest-shaped, submaxillary incision extending from the submental area to behind the angle of the jaw. The anterior margin of the mandible is freed with a Gigli saw and the combined specimen of jaw, contents of the submaxillary space and tip of the parotid gland are delivered laterally from the wound. When the carcinoma is in the commonest site, the midportion of the horizontal ramus this is accomplished by releasing the mandible at the mental foramen and splitting the mylohyoid muscle medially and the buccinator muscle laterally and splitting the deep fascia of the submental space. As the dissection is carried posteriorly, the submaxillary gland and its associated fascia are delivered along with the mandible, its periosteum and mylohyoid attachments. The inferior portion of the parotid gland is included in the specimen. The insertions of the internal pterygoid and masseter muscles are cut, and the specimen is liberated by transecting the mandible again just above its angle. It is usually possible to save the ascending ramus in this type of case, particularly when the primary lesion has not extended to the tongue.

III Hemisection of the Mandible for Extensive Carcinoma of the Alveolus and Mandible with Extension to the Floor of the Mouth and Tongue Without Clinical Evidence of Metastasis in the Neck—When the primary lesion has extended to the floor of the mouth and tongue (and the same applies for a primary lesion of the floor of the mouth or tongue extending to the mandible), yet there is no clinical evidence of extension to the neck, a combined suprahyoid dissection is performed in continuity with the resection of the jaw and tongue. The lower lip is split vertically in its midline, and this incision is connected with the previously described submaxillary incision (fig 2). The removal of a section of tongue, floor of the mouth and contents of the submaxillary and submental spaces along with the jaw is begun anteriorly by first transecting the mandible with a Gigli or electric saw and continuing the dissection posteriorly as previously described. In cutting the floor of the mouth and tongue it is usually necessary to remove the major

portions of one side of the genioglossus, hyoglossus and mylohyoid muscles and occasionally portions of the anterior belly of the digastric and styloglossus muscles. When the lateral margin of the tongue is involved, the dissection is usually carried posteriorly to the depth of the tonsil. The internal and the external pterygoid, masseter and temporalis muscles and mandibular nerve are stripped from the ascending ramus, and it is avulsed from the glenoid cavity.

Even though it is possible to save the ascending ramus in some of these cases, it is often unwise to attempt immediate reparative and

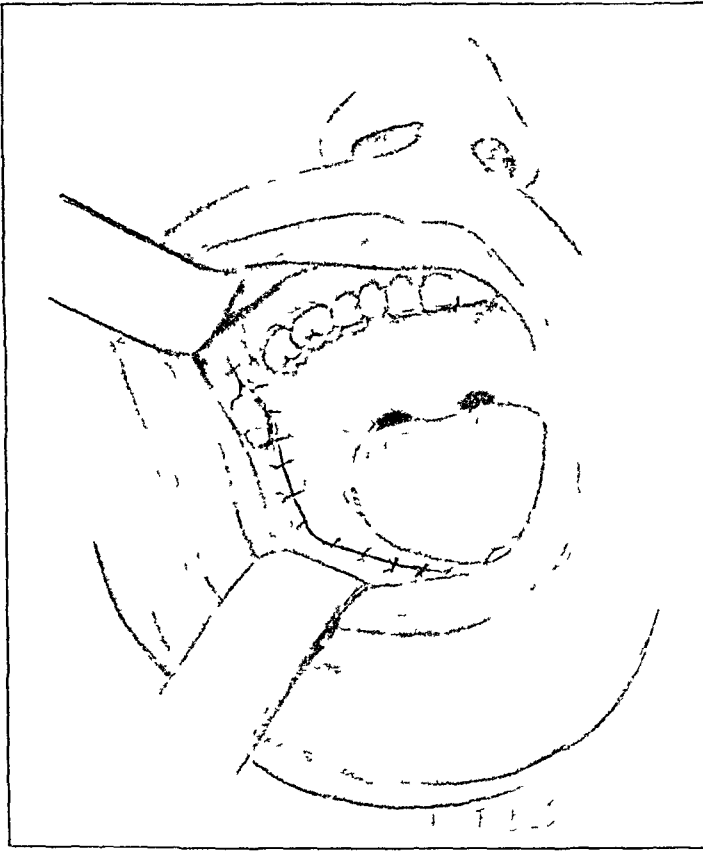


Fig 8—Closure of the wound after the intraoral approach for hemiresection of the mandible

reconstructive bone grafting. This is particularly true when irradiation has been used prior to the surgical procedure. It is well to bear in mind that the prime consideration in all these cases is the cure of the cancer and that all other procedures are of secondary importance. If there are doubts about an immediate bone graft, and there frequently are, the procedure should be eliminated. It may then be done after permanent cure is established. Occlusion of the jaws should be maintained for six weeks with intermaxillary wires to prevent undue distortion of the remaining fragment. Internal appliances are then adapted to pro-

mote a normal bite In many patients who have not received this special attention, there is often a very satisfactory adjustment to their deformity and eating habits If the operator has the opportunity and elects to graft, the mandibular joint and a small portion of the ascending ramus should be preserved This facilitates the grafting procedure and improves the postoperative functional result A rib or the iliac crest may be used as donor material, or a metal splint may be substituted for a bone graft Here, as in all grafting procedures, the principles of asepsis and immobilization are imperative

The intraoral approach may be utilized for the more limited type of cancer requiring hemiresection (fig 8)

IV Resection of a Portion or All of the Mandible in Continuity with a Lateral Neck Dissection for Extensive Cancer of the Jaw and Floor of the Mouth with Metastasis to the Neck—Far advanced cases present any degree of local cancerous involvement plus definite metastatic extension to the upper or deep neck In all these cases treatment consists in a combined resection of the primary cancer, which may include a portion of the tongue, cheek, floor of the mouth and mandible, in continuity with the complete lateral neck contents en masse The technic for the combined radical resection of the lateral part of the neck and jaw includes the preparation of four neck flaps containing skin and subcutaneous tissue This procedure is begun by an incision parallel to the anterior border of the sternocleidomastoid muscle extending from the mastoid bone downward to the clavicle A modified Z is created by continuing from the midportion of the first incision into the submental area and from slightly below the midportion of the first incision to the lateral border of the clavicle Undermining the skin beneath these three incisions creates four flaps, which when elevated expose the lateral portion of the neck (fig 9)

When the carcinoma has not extended to the tongue or floor of the mouth, the mandible may be engaged through the submaxillary and submental approach by the upward elevation of the superior flap However, when the tongue and floor of the mouth are involved, a vertical incision in the middle of the lower lip is directly connected with the submental extension of the incision in the neck, thus permitting ready access to the entire neck, mandible and mouth The general specimen is first attacked inferiorly by doubly ligating the inferior part of the external jugular vein and freeing the platysma, sternocleidomastoid and omohyoid muscles at their clavicular levels After the inferior portion of the internal jugular vein has been doubly ligated, the carotid artery, deep and superficial fascia, internal and external jugular veins, platysma, sternocleidomastoid and omohyoid muscles along with the fat and areolar tissue are rolled upward from the level of the clavicle in their liberation from the deep part of the neck The thoracic duct should be protected

when the dissection is performed on the left side of the neck. This resection usually permits visualization of the upper portion of the brachial plexus, the scalenus anticus and medius, levator scapula and trapezius muscles. The fifth and sixth cervical nerves are preserved. The phrenic portions of the third, fourth and fifth cervical nerves are maintained intact, but the superficial branches of the second, third and fourth cervical nerves are cut along with the spinal accessory nerve and included in the lateral neck specimen that is being liberated from below upward. At the level of the bifurcation of the common carotid artery, a 4 per cent solution of tetracaine hydrochloride (pontocaine hydrochloride®) is

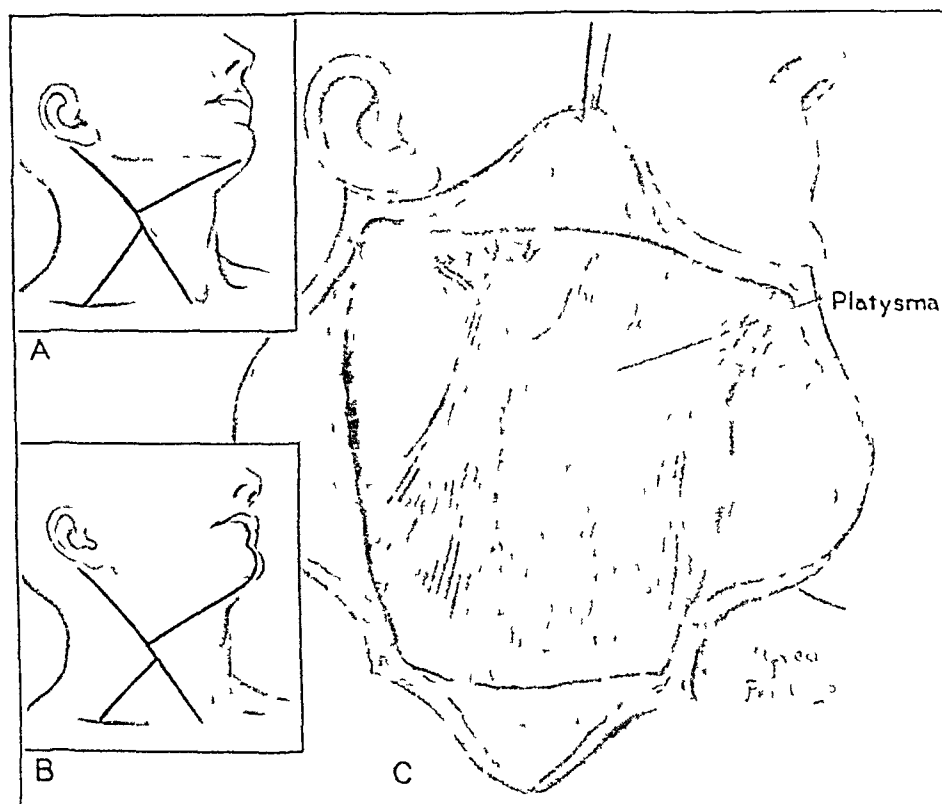


Fig 9—A, three incisions in the lateral part of the neck for the creation of four neck flaps. B, extension of the submaxillary incision to the lower lip for intra-oral exposure. C, elevation of the neck flaps and exposure of the contents of the lateral portion of the neck.

applied topically and the external carotid artery tied above the superior thyroid branch. It is not necessary to cut the external carotid artery. The mandible is transected well anterior to the primary carcinoma with a Gigli or electric saw. If the primary carcinoma has not extended beyond the mandible internally, the contents of the suprahyoid space and the jaw bone with its periosteum and associated soft tissues are liberated into the wound in the upper part of the neck without cutting the lower lip. A section of the horizontal ramus or half of the mandible may be included in this delivery. The dissection is carried posteriorly,

including the inferior tip of the parotid gland. Care should be exercised to preserve the lingual, hypoglossal and mandibular branch of the facial nerves. Thorough removal of the submaxillary, subdigastric and carotid fasciae is important in this type of cancer. Finally, the origin of the sternocleidomastoid muscle is freed from the tip of the mastoid process, the superior portions of the external jugular, internal jugular and communicating veins are doubly ligated and the combined specimen of jaw and lateral neck content removed en masse (fig 10)

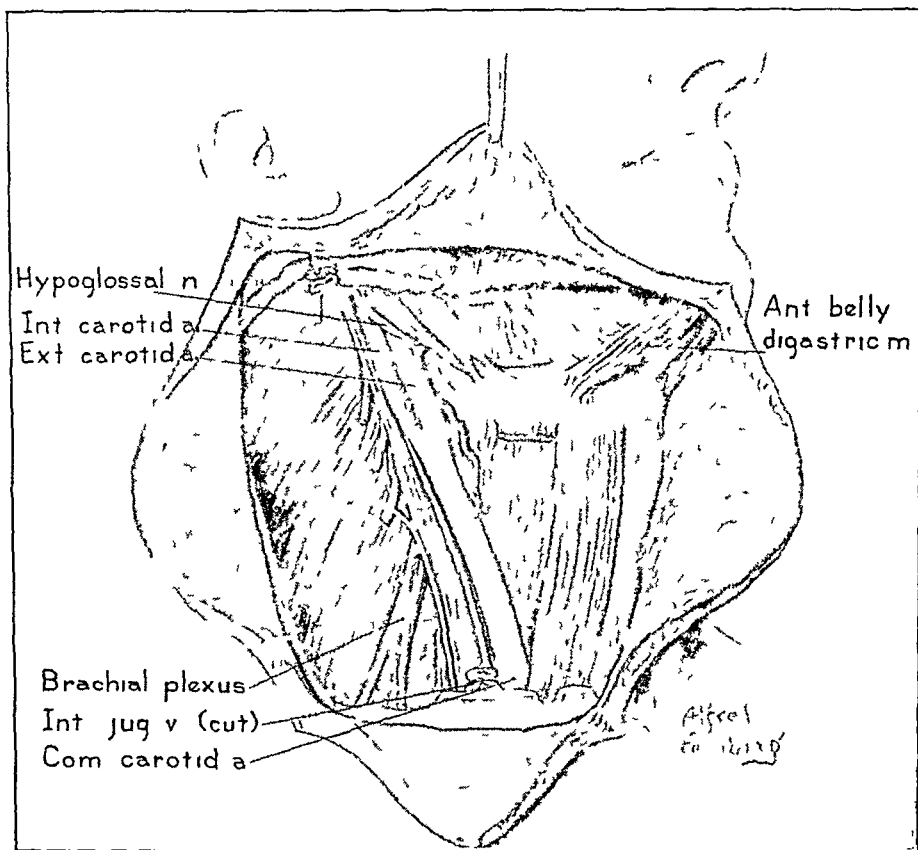


Fig 10—The contents of the lateral portion of the neck have been removed

When the primary carcinoma has extended to the floor of the mouth and tongue, a more open approach and exposure is indicated for the additional resection that is required within the mouth. This is accomplished by connecting a vertical incision in the middle of the lower lip with the submental extension of the incision in the neck (fig 9 B). After the anterior part of the mandible is transected with the Gigli or electric saw, the involved portions of the tongue and floor of the mouth are cut free from the normal oral tissues beginning anteriorly at the tip of the tongue. These additional organs are included in the specimen along with the bone and contents of the neck as the dissection is carried

posteriorly in the mouth. In the vast majority of these cases disarticulation of the mandible is required, which, as previously described, is accomplished by freeing the ascending ramus of its periosteum, muscle and nerve attachments and forceful avulsion from the socket. The dissection of the tongue and floor of the mouth is as previously described. The point at which the intraoral resection adjoins the mandible posteriorly depends on the size and position of the extension of the carcinoma in the mouth. Usually it is at the depth of the palatoglossus muscle (fig 3).

Bilateral resection of the horizontal ramus and total resection of the mandible are not common procedures. This technic is usually per-

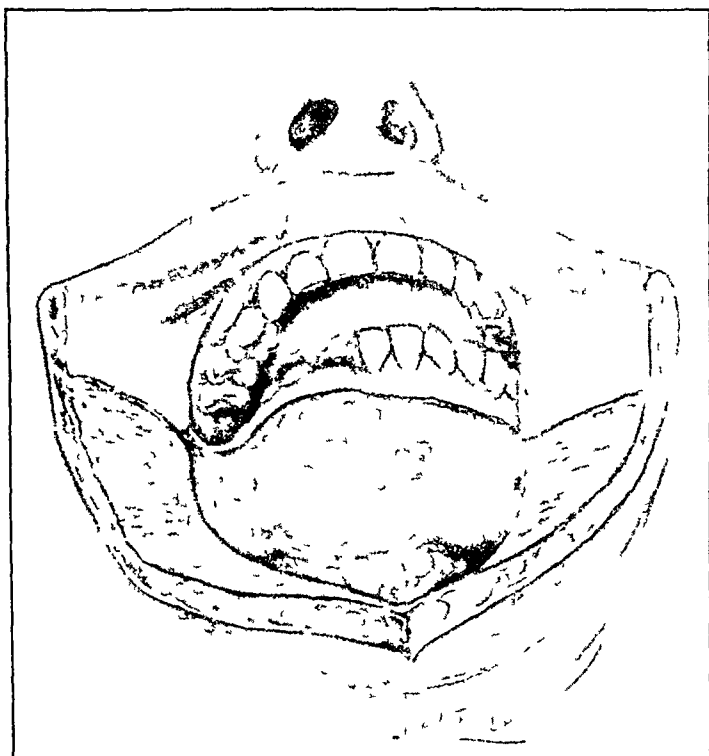


Fig 11—Bilateral lower lip flaps are utilized in case of extensive cancer of the jaw and mouth

formed in cases of extensive malignant tumors of the jaw which have been previously unsuccessfully treated by irradiation and inadequate surgical procedures. Frequently the floor of the mouth, lip and neck have been invaded by the cancer, and it is necessary to remove these organs in continuity with the mandible and neck contents.

A bilateral lower lip flap in association with the neck flaps facilitates the exposure greatly, permitting both horizontal ramus to be readily visualized. The lower lip flaps are prepared by splitting the lower lip vertically in the midline to 1 inch (2.5 cm) below the mandible. The flaps are then freed laterally to the angles of the mandible (fig 11).

The thickness of these lip flaps is determined by the extent and position of the malignant tumor in the mandible. In bilateral resection of the horizontal rami, the jaw is transected at the angles with the saw or bone-cutting forceps. The freed section is then removed in continuity with all adjacent and involved tissue en masse, as has been described previously. This may include a bilateral suprahyoid or lateral neck dissection. One jugular vein should be preserved, and two to three weeks should elapse between resections of the entire lateral neck contents. We have performed bilateral radical neck dissections with sacrifice of both internal jugular veins within the short interval of ten days.

For complete mandibular resection, one ascending ramus is liberated of all its attachments and avulsed. By manipulating this freed end, the other portion is gradually delivered and avulsed in the manner described. The labial and the buccal mucosa are approximated to the floor of the mouth, and the dead space is eliminated by buried chromic surgical gut sutures. The tongue is shortened. There is considerable recession of the chin, but if the motor function of the tongue and lips is preserved, remarkable rehabilitation may be accomplished in the relearning of articulate speech and in the handling of saliva and food.

The general plan of closure of all wounds of the mouth and neck consists in approximating the cut edge of the buccal mucosa of the cheek with the cut edge of the remaining tissue in the mouth, whether that be the floor of the mouth or the cut border of the tongue. Closure in layers with chromic surgical gut beginning posteriorly and working anteriorly to the midborder of the lower lip is preferred in the elimination of the intraoral fenestra and the reconstruction of a new floor of the mouth. The tip of the tongue should be repaired separately in order to maintain its facility. If a large section of the tongue has been removed with the specimen, the intraoral closure should be reinforced by large through and through sutures. All bleeding is controlled with fine silk ties. The neck flaps are adjusted into their original position and the skin wound is closed with fine interrupted black silk. It is important to maintain adequate drainage at the anterior and lateral inferior portions of the wound. A prophylactic tracheostomy is indicated. A Levin feeding tube is most helpful in maintaining nutrition and also in putting the mouth at rest and facilitating the healing process about the newly constructed floor of the mouth. The remaining mandibular segment is maintained in position by the application of intraoral prostheses after recovery from the operation. Chemotherapy and biotherapy are important in preventing and controlling infection.

Immediate reconstructive surgery is limited in the type of case that has just been described, consisting of radical resection of most of the jaw and contents of the neck. At present, immediate bone grafting is not recommended when the dissection has sacrificed a portion of the tongue, floor of the mouth, jaw and lateral neck contents. It is true

that the most advantageous time to reconstruct the mandible is at the completion of the operation for its removal when this is warranted. An appropriate bed already exists for the implantation of the bone graft. The distortion caused by scar and muscle contracture, which always appears to some degree after the mandible is removed, does not exist. The problem of utilizing a twisted section of the ascending ramus at a later date is averted. The patient is specifically benefited by preservation of the contour of the face and the complete utilization of his mandible as an eating and speaking instrument. The psychic effects of being deprived of these advantages may be serious. Yet, unhappily, it is frequently impossible and unwise to attempt immediate complete reconstruction of the mandible. The factors mitigating the hope of ideal repair are the great loss of bony and soft tissues. Often structures vital to the reconstruction technic must be sacrificed with the specimen. Frequently the size of the resected segment of mandible not only makes the procurement of a similar piece of bone difficult but embarrasses the fixation and immobilization of it. There is always an extensive amount of tissue trauma. The area, because of its association with the oral cavity, is potentially infected. Active infection is often present in the tumor and soft tissues and bone. Often the area has been scarred by inadequate previous surgical procedures. Frequently the tissues have been devitalized by unsuccessful irradiation. However, the strong desire to rehabilitate the patient completely from a functional, psychic and physical point of view is discovering new methods of overcoming the old obstacles. Modeled vitallium and tantalum mandibular implants may be fixed to the ascending ramus when the hazards of a free bone graft are excessive. Perhaps it will be possible to employ prepared mandibles procured from bone banks in the near future in the reconstruction of the more extensive resections. The complete use of the services of the dental prosthetist to assist in maintaining a normal bite and in preventing undue contracture prepares the way for secondary reconstructive procedures.

REPORT OF CASES

No attempt is made in this paper to present a statistical analysis, and a brief summary of only 6 cases representing the various surgical technics described in the article is hereby presented to clarify situations pertaining to each case. Although hemiresection of the mandible is the operation that is most frequently performed, only 1 case of that type will be discussed to illustrate certain features pertaining to the indications and use of that operation.

CASE 1—*Segmental resection of a portion of the mandible*

A 57 year old white man originally underwent treatment by the application of radium to an epidermoid carcinoma grade 2 of the lip in 1931, 1934 and 1937. In

1944 the lip and chin were again treated with the application of radium and also by roentgen therapy. The patient was then seen in this clinic, and examination revealed a large, ulcerating and perforating defect in the lower lip and chin, solidly infiltrated with carcinoma. The gingivolabial gutter was involved by this carcinomatous process, and the lesion was firmly adherent to the periosteum at this site. The lower incisor teeth were necrotic and loose. Stereoscopic examination of the jaw revealed apical abscesses of these teeth but no specific evidence of cancer.

The surgical approach to this problem included the entire resection of the remainder of the lower lip and chin along with the periosteum and upper portion of the mandible at this site. It was possible in this case to free the periosteum from the inferior border of the mandible between the mental foramens superiorly, approximately $\frac{1}{2}$ inch (1 cm). The upper portion of the mandible containing the teeth was freed with a horizontal incision and two vertical incisions in the bone. The bone, teeth, periosteum and soft tissue about the chin and lip were



Fig 12—Segment of the anterior portion of the mandible associated with the lower lip. The inferior rim of the mandible has been preserved.

removed en masse. A thin rim of mandible between the mental foramens, measuring slightly less than $\frac{1}{2}$ inch in width, was preserved inferiorly. This bone appeared perfectly healthy. There was no evidence of metastasis to the neck. A new lip was immediately created by transposing lateral cheek and mucous membrane flaps medially over the preserved arch of the mandible. The post-operative course was uneventful, and the patient has been free of disease for two and a half years (fig 12).

CASE 2—*Sectional resection of the mandible with immediate iliac bone graft*

A 58 year old white man presented a grade 2 squamous cell carcinoma of the posterior portion of the right alveolus. The patient's history revealed that the third molar tooth became loose in the socket and was extracted eight months before he visited this clinic. This socket failed to heal, and a small ulcer appeared. Examination revealed a small depression over the socket of the third molar on the right side of the mandible manifesting a tendency to heal over completely, which is unusual in the mouth. It measured approximately 1.75 by 0.75 cm and was directly

over the socket Both gutters were free There was no evidence of metastasis to the neck Stereoscopic examination of the mandible failed to reveal a cancerous process in the bone

Surgical procedure included the complete release of a section of the mandible at this site, measuring approximately 6 cm in length and including the bucco-



Fig 13—View of the face and free bone graft held in position by tantalum wire one year after operation

alveolar gutter and the glossoalveolar gutter and their soft tissue and mucous membrane contents The surgical approach was through a crescent-shaped incision in the right submaxillary space The submaxillary gland was not resected Immediate repair and reconstruction were accomplished by the use of a free osteo-

periosteal iliac bone graft which was modeled to correspond to the size and shape of the section of mandible that was removed. It was fixed in position by two tantalum wires through the ascending ramus and the posterior segment of the bone graft and two tantalum wires through the anterior section of the bone graft and the anterior free edge of the mandible. It was further immobilized by passing two tantalum wires completely around the internal and external surfaces of the graft and fixing these wires to the remaining sections of mandible. No external fixation was utilized. The patient was fed with a Levin tube for approximately a month and was then given a liquid diet for the second month and gradually rehabilitated over the next six weeks. The postoperative course was uneventful, and the patient has been free of disease for one and a half years (fig. 13).

A second case of carcinoma of the right alveolus and horizontal ramus is presented because of the utilization of a different technic in the sectional bone grafting procedure.

CASE 3—Sectional resection of the horizontal ramus in continuity with the submaxillary space contents and immediate reconstruction with free iliac bone graft and internal fixation

A 48 year old white woman revealed that a whitish, thick nonulcerative area had existed underneath a poorly fitting dental prosthesis for several years. She was aware that this had been ulcerated for approximately six months. Examination revealed a poorly fitting prosthesis on the mandible, moderately advanced leukoplakia of the right alveolus and a grade 2 epidermoid carcinoma of the midportion of the right alveolus and ramus. It measured approximately 2 cm. in length and 1.5 cm. in width. The buccoalveolar and glossoalveolar gutters were free. There were no abnormal masses in the neck. The lesion had deeply ulcerated into the bone. Stereoscopic studies of the mandible revealed erosion of a section of the superior portion of the horizontal ramus on the right side at the site of the carcinoma.

The mandible was approached through a crescent-shaped right submaxillary skin incision, and a right cheek flap was created external to the platysma muscle well above the buccoalveolar gutter. A portion of the sublingual gland and the contents of the submaxillary space were incorporated in the liberation of the internal portion of the mandible. This section of mandible, periosteum, alveolus, mucous membrane of buccoalveolar and glossoalveolar gutters, platysma, a portion of the musculature of the floor of the mouth and a section of the sublingual gland and contents of the submaxillary space were removed en masse well beyond the gross limits of the carcinoma. Immediate reconstructive procedures were performed with utilization of a free osteoperiosteal iliac bone graft which was modeled to correspond to the size and shape of the section of mandible removed. The intra-oral fenestra was closed first in double layers with no. 1 atraumatic intestinal chromic surgical gut. The bone graft was then affixed to the ascending ramus and the anterior section of the mandible with braided tantalum wire through holes in the graft and the sections of mandible. Complete immobility and fixation of the archway was then accomplished by the application of a modeled stainless steel bone plate which was previously prepared to fit this reconstruction. With the aid of the bone plate the graft was securely fixed in position with two screws and then anchored to the ascending ramus with one screw and to the anterior segment of the mandible with another screw, thus fixing the two free segments of the mandible, the bone graft and the bone plate into a permanent, completely stabilized

mandibular arch. This patient was operated on six months before the time of this report. Examination of the surgical specimen did not reveal cancer in any of the cervical lymph nodes.

This technic of reconstruction is, in general, superior to the other technic because of the absolute fixation of the bone graft and the more rapid rehabilitation of the patient (fig 14).



Fig 14—View of face and free bone graft held in position with a modeled stainless steel plate and screws three months after operation.

CASE 4—Hemisection of the mandible and suprathyoid dissection in continuity

A 52 year old white woman stated that she had been aware of the presence of a tumorous mass on the right side of her jaw for approximately eighteen months before she sought medical aid. Examination revealed a chronically infected, deeply ulcerating, foul-smelling, epidermoid carcinoma grade 2, measuring approximately 4 cm. in length and 2 cm. in width in the right glossoalveolar sulcus involv-

ing the alveolus, the internal part of the mandible and the adjacent floor of the mouth. It was associated with the horizontal ramus. There were no teeth at this site. There was no evidence of metastasis to cervical nodes. The surgical procedure was performed through a submaxillary incision and included ligation of the right external carotid artery and hemiresection of the right side of the mandible including the floor of the mouth, a small section of the tongue, the palatoglossus fold, the submaxillary gland and a portion of the sublingual gland and tip of the parotid gland. The intraoral fenestra was closed with no. 1 chromic surgical gut in layers, the margin of the tongue being sutured to the cut edge of the buccal mucosa. The wound in the neck was closed with fine black silk, with a drain in the inferior pole. There was no evidence of cancer in any of the lymph nodes of the neck. The postoperative course was uneventful, and there was no evidence of cancer twenty-eight months postoperatively.

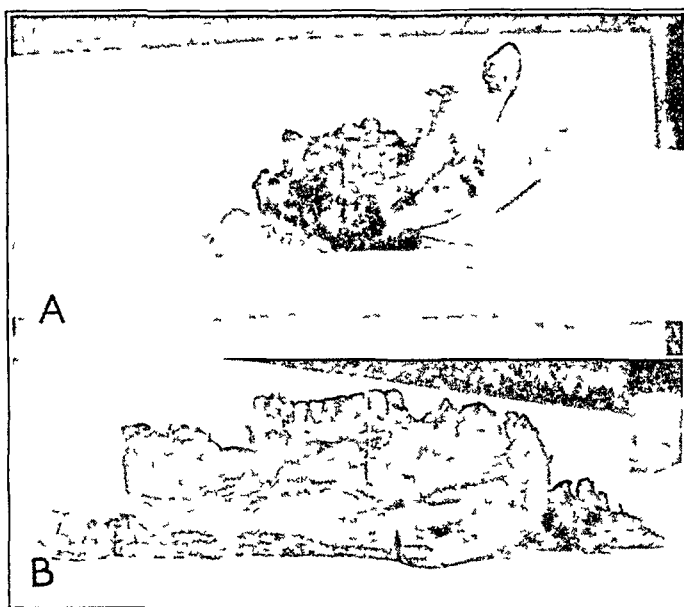


Fig 15—*A*, specimen containing half of the mandible, tip of the parotid gland, contents of the submaxillary space, sublingual gland, floor of the mouth and lateral margin of the tongue. *B*, resection of both horizontal rami and left ascending ramus with bilateral radical suprahyoid dissection and resection of associated skin. (This specimen had been fixed in formaldehyde solution U S P and sections removed for analysis before this photograph was taken.)

This case illustrates the treatment of a more advanced type of carcinoma, including the radical resection of not only the bone but also a portion of the associated soft tissues. The continuity of the mandibular arch is maintained by intermaxillary wiring and the application of appropriate intraoral bars and splints to the maxilla and remaining section of the mandible. Complete rehabilitation and orientation of persons who have undergone this type of operation are considerably more difficult than of patients receiving immediate reconstructive procedures, including bone grafting (fig 15 *A*).

CASE 5—Bilateral resection of the horizontal ramus and the ascending ramus on one side with bilateral suprahyoid dissection in continuity

A 58 year old white man revealed that he had been treated for carcinoma of the lower lip six years before the time of this report. Approximately two and a half years ago he became aware of a swelling in the left submental space. After a formal biopsy this was treated by roentgen irradiation and the application of radium. After the interval of a year tumors began to appear on both sides of the site of the original mass in the neck. These were removed by limited surgical intervention. Shortly before visiting this clinic, the patient noticed that the tissues about the jaw were beginning to swell again. Examination revealed a post-irradiation scar on the left lower lip but no evidence of recurrence of the epithelioma at this site. The tissues about both horizontal ramus were diffusely involved with metastatic deposits of cancer. The upper part of the neck and the floor of the mouth were markedly indurated as a result of the previous surgical procedure and irradiation. The infiltrative process about the upper part of the neck had invaded the periosteum and bone of both horizontal ramus. Stereoscopic examination of the mandible failed to reveal the invasion of the bone by the carcinomatous process. However, microscopic report on the tissues of the upper part of the neck and mandible revealed massive direct extension of squamous cell carcinoma grade 2 into all of the soft tissues about the mandible and also into the mandible. The surgical technic in this case was accomplished by a crescent-shaped bilateral suprahyoid incision with the creation of bilateral cheek and chin flaps. The entire mandible, except a portion of the right ascending ramus, was removed in continuity with a bilateral suprahyoid dissection. The muscular activity of the lower lip and also the tongue were maintained intact. The wound was closed by suturing the under surface of the tongue to the lateral cheek wall with interrupted no. 1 chromic surgical gut in layers, forming a new floor of the mouth. A prophylactic tracheostomy was performed. The postoperative condition was characterized by the sincere efforts of this patient to relearn a new method of handling food and saliva and also learning to speak intelligibly. If the motor function of the lips and tongue is maintained, this is accomplished without too much difficulty. Complete reconstruction in this type of case should be delayed because of irradiation effects on the tissue, postsurgical scar formation, the extensive sacrifice of tissue which is necessary to eradicate the carcinoma and the extensiveness of the carcinomatous involvement. This patient is well two years following his operation (fig 15 B).

CASE 6—Hemiresection of the mandible and floor of the mouth and partial glossectomy in continuity with complete lateral neck dissection

A 55 year old white man stated that a painless ulcer had appeared on the right side of his jaw bone approximately seven months ago. It spread to the floor of the mouth and was then treated by roentgen therapy. The major portion of the ulcer disappeared, but recently the jaw became painful and a lump appeared in the neck. Examination revealed a large squamous cell grade 3, ulcerated cancer of the right horizontal ramus with extension to the floor of the mouth and one lymph node containing metastatic cancer in the submaxillary space. Stereoscopic roentgenograms revealed destruction of bone of the horizontal ramus.

The surgical approach consisted in the creation of the lateral neck and lower lip flaps. This was accomplished by connecting the vertical incision in the middle of the lower lip with the submental extension of the neck incisions.

A complete right lateral neck dissection was performed up to the hyoid bone. Then the mandible was transected anteriorly and liberated in conjunction with the floor of the mouth, a section of tongue, sublingual gland and contents of the submaxillary space contents. The tip of the parotid gland was cut off and the subdigastric space carefully dissected. The superior portion of the internal jugular vein was ligated and the sternocleidomastoid muscle freed from the tip of the mastoid process. All muscular and nerve attachments of the ascending ramus were stripped and the mandible avulsed from the socket. A combined specimen of lateral neck contents, portion of the tongue, floor of the mouth and mandible was removed in continuity. The wound was closed as described in the text. The postoperative course was uneventful and the patient has been free of disease for two years (fig 16)

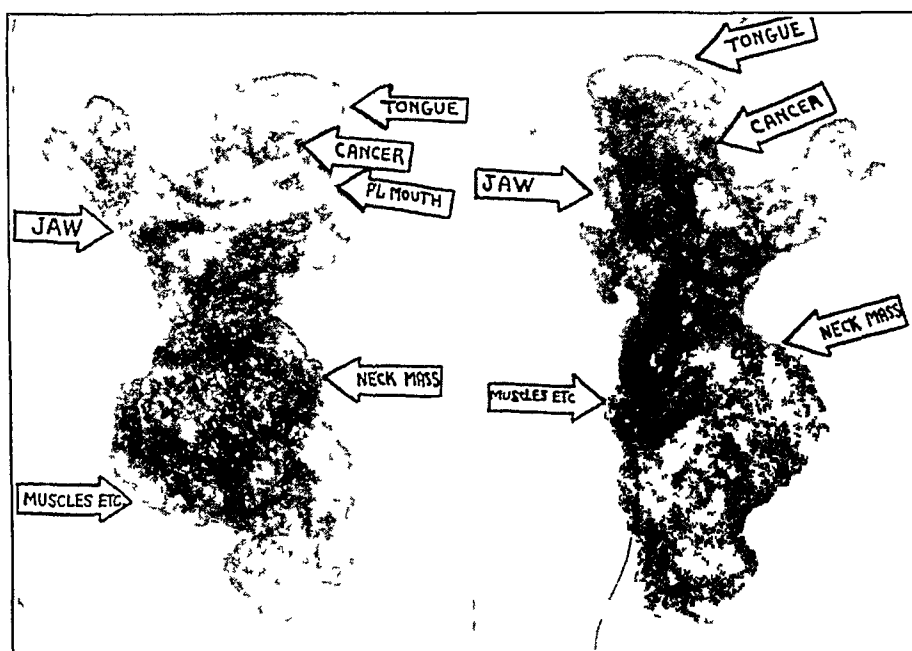


Fig 16—Specimen containing a portion of the tongue, floor of the mouth, half of the mandible and entire lateral neck contents

SUMMARY

- 1 A classification of the primary types of malignant tumors of the mandible is presented
- 2 A classification of the various types of cancer of the mandible in respect to size, position and extension is stated
- 3 Four basic surgical techniques with individual modifications are recommended for the treatment of these cases
- 4 Immediate reconstructive surgery is discussed and qualified
- 5 Six illustrative cases are reported to clarify the analysis and surgical approach to the various degrees and types of cancer of the mandible

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SURGICAL CORRECTION OF THE ABNORMALLY PROTRUDING EAR

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NUMEROUS methods of correcting a protruding auricle have been described, and in the main they are satisfactory for setting the ear closer to the head. However, the object of restorative surgery for any deformity is to reproduce the normal as accurately as possible, a standard which most accepted technics of otoplasty fail to fulfil.

An examination of some of the more recently published procedures for the correction of outstanding ears reveals a gradual progression toward the goal of attaining perfection of results. The purpose of this paper is to present an original method of otoplasty which in my experience has yielded results that more satisfactorily simulate the normal, to discuss the underlying factors in the etiology and development of protruding ears and to review the history of the operative procedures.

ETIOLOGIC FACTORS

Malformations of the auricle are not unusual and may range in severity from complete absence to macrotia. By far the commonest deformity is the protruding ear.

The embryonic origin of the external ear is still a controversial matter, but most observers agree that the six tubercles, or hillocks, of the first branchial groove, which appear about the fifth week of embryonic life, develop into the pinna. The history of these hillocks and their role in the formation of the auricle have been evaluated by a series of investigators, namely, His, Gradenigo, Schwalbe,¹ Baum and Dobers, Henneberg, Streeter² and others. The consensus is that the hillocks are gradually fused and transformed into the adult ear. For convenience, these hillocks are numbered from 1 to 6, three

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¹ Schwalbe, G. Die Ohrmuschel, in *Handbuch der Anatomie des Menschen*, Jena, G. Fischer, 1898, vol. 5, p. 113.

² Streeter, G. L. Development of the Auricle in the Human Embryo, *Contrib. Embryol.* **14** 111-138, 1922.

hillocks develop on the mandibular arch and three on the hyoid arch of the first branchial groove. Below the hyoid arch a fold of the hyoid integument is formed and is known as the auricular fold. A similar fold appears below the first branchial groove and unites with the auricular fold to form the free margin of the auricle. According to Schwalbe,¹ the points of fusion of these two folds mark the position of the satyr tubercle. Darwin's tubercle occurs about the middle of the margin of the free auricular fold and corresponds to the apex of the auricle in lower mammals. The tragus is derived from mandibular hillock 2, the helix, from mandibular hillocks 2 and 3, the anthelix, from hyoid hillocks 4 and 5, and the antitragus, from hyoid hillock 6. The lobule represents the lower end of the auricular fold.³ Hammar⁴ stated the opinion that the scaphoid fossa is the result of the closure of the branchial cleft.

Wood-Jones and Chuan⁵ stated the belief that the pinna is a completely hyoid derivative and that the mandibular contribution is represented only by the tragus and the anterior part of the external auditory meatus. They based their conclusions on the finding of an absence of the tragus in cases of micrognathia or complete agnathia in the presence of a well formed pinna. Further evidence to substantiate their conclusions is based on my own observations in cases of congenital absence of the ear. In all these cases of absence of the auricle in the presence of a well formed mandible, evidence of a tragus and lobule was found.

At the end of the third month of embryonic life the hillocks are well defined and the ear begins to assume definite form. According to Evans,⁶ it is at this time that the greatest number of malformations occur. Fraser,⁷ however, stated the opinion that it is during the second month of embryonic life that maldevelopments appear. The ear margin at this time is pointed, and, because the crura of the anthelix are not formed, the ear protrudes from the head. Davis and Kitlowski⁸

3 Streeter² Arey, L. B. *Developmental Anatomy*, ed 4, Philadelphia, W. B. Saunders Company, 1940.

4 Hammar, J. A., cited by Eggston, A. A., and Wolff, D. *Histopathology of the Ear, Nose and Throat*, Baltimore, Williams & Wilkins Company, 1947, p. 62.

5 Wood-Jones, F., and Chuan, W. I. *Development of the External Ear*, *J. Anat.* **68** 525-533, 1934.

6 Evans, H. M. *The Origins of Hearing—Random Variation or Convergent Evolution—Study of Auditory Organ and Its Swim-Bladder Connections in Fishes*, *J. Larvng. & Otol.* **50** 649-670, 1935.

7 Fraser, J. S. *Maldevelopment of the Auricle, External Acoustic Meatus and Middle Ear. Microtia and Congenital Meatal Atresia*, *Arch. Otolaryng.* **13** 1-27 (Jan.) 1931.

8 Davis, J. S., and Kitlowski, E. A. *Abnormal Prominence of the Ears. A Method of Readjustment*, *Surgery* **2** 835-848, 1937.

stated that about the sixth fetal month the margin curls, forming the helix, the anthelix becomes more definitely folded and its crura appear. It is the folding of the anthelix and the development of the crura that are responsible for bringing the ear closer to the head.

The protruding ear, therefore, is embryonically a congenital deformity in which hyoid hillocks 4 and 5 are involved. It is inherited according to mendelian law and may be dominant or recessive. Heredity is a factor which occurs repeatedly in many of my series of cases and in cases reported in the literature. Potter⁹ reported that a dominant gene may be transmitted through many generations. She revealed the transmission through five generations of a malformation in which the ears were extremely cupped and protruding. A family tree embracing 92 members was obtained in the study. On the average, half of the members with this deformity had transmitted it to their children, while normal siblings married to normal persons had not transmitted the defect.

The cause of the malformation is a hereditary one, but in rare cases intrauterine injury may account for a mild deformity of the auricle. An umbilical cord twisted around a child's head may be the responsible factor in producing a unilateral deformity of the ear.⁷

Imhofer¹⁰ stated the opinion that certain peculiarities of formation of the auricle are an important aid in the establishment of descendants, as, for example, in cases in which the parentage of a child is in doubt. In a few of my cases a mother and child had the identical type of protruding ears. Tracing the family pedigree in one of these cases revealed that the mother was one of four children, of whom a brother had a similar deformity, while the other two siblings, a brother and a sister, were free of any deformity. The father in this case had no auricular deformity, but the mother had protruding ears. In the majority of my cases a history of a similar deformity in some other member of the family was obtained.

CLINICAL SIGNIFICANCE

Since little importance can be ascribed to the function of the auricle, it is only because of the deleterious psychic effect on the patient that protruding ears assume a clinical significance. Actually, according to comparative anatomists, the external ear in man is undergoing regression. In comparing the auricular muscles in man with those of animals with ears of similar type, a definite decrease in size, even to atrophy is evident. In lower animals the auricle has real function in determining

⁹ Potter, E. L. A Hereditary Ear Malformation Transmitted Through Five Generations, *J. Hered.* **28** 255-258, 1937.

¹⁰ Cited by Politzer, A. A Text-Book of the Diseases of the Ear, London, Bailliere, Tindall & Co., 1909.

direction of sound and in protecting the internal auditory mechanism. Some animals, on stimulation of the tragus, will close the auditory canal by an infolding of the auricle to serve as a protection against water or insects. Henneberg¹¹ and others observed that some mammals of the aquatic and semiaquatic group, such as the muskrat, seal and beaver, can close the external ear when they are irritated by mechanical or electric stimulation or when plunged into water. Henneberg observed that the Norwegian brown rat, which is a semiaquatic mammal, after coming out of the water shakes its head violently before opening its ears. If prevented from shaking its head by being held at the nape of the neck, it refuses to open its ears. The closure is affected by pulling the tragus and antitragus together, as well as the anthelix and scapha, so that the external meatus is effectively closed. Rodents, moles and other ground-burrowing animals are also capable of closing the external meatus.

Of all the depressions on the anterior surface of the auricle, it is principally the concha which collects a portion of the sound waves and reflects them into the meatus. Schneider¹⁰ proved that a slight decrease in hearing power takes place if this depression is filled with wax. The size of the auricle and the angle formed with the head also have a slight influence on the reflection of sound into the meatus. This is evident from the fact that persons of normal hearing, as well as those who are hard of hearing, hear somewhat better if the auricle is bent forward or is augmented by cupping the hollow of the hand over it. Although no real difficulty in hearing results from loss of the auricle, nevertheless, sound will not be perceived as distinctly and fully as though the auricle were present.

The psychic effects of protruding ears vary with the sensitivity of the individual person. In almost all my patients, and, surprisingly enough, the effect was pronounced in children, a feeling of insecurity was evident, since this deformity, unlike most malformations, produces reactions of mirth in other people. To be constantly reminded of and ridiculed about a deformity will break all defense mechanisms of repression which the patient might have formed and subjects him to the development of an insecurity or inadequacy neurosis. It is fortunate for these persons that this deformity can be corrected simply and satisfactorily, preferably at an early preschool age, before any real psychic trauma can be inflicted. Many who appear outwardly capable of rising above some defects may be sensitive about them and suffer inwardly. Other patients who are not at all sensitive about their appearance or defects may desire a correction of the ears purely for economic or social reasons.

11 Henneberg, B. Ueber die Bedeutung der Ohrmuschel, *Anat. Hefte* 40 95-147, 1909-1910.

ANATOMIC AND PATHOLOGIC FEATURES

The normal ear is a thin, shell-like structure, having definite depressions and projections. Many variations are found which may still be considered within normal limits. It is only when the ear protrudes abnormally or is absent that the defect is immediately noticeable. Very large or very small ears which may be proportionately more deformed than a protruding ear may go unnoticed if they are placed in a normal relation to the head.

The normal auricle, or pinna, is described by Gray¹² as ovoid with its larger end directed upward (fig 1). The prominent rim of the auricle is called the helix. Where the helix turns downward, a small projection, known as Darwin's tubercle, is frequently seen. This tubercle is very evident about the sixth month of fetal life, when the

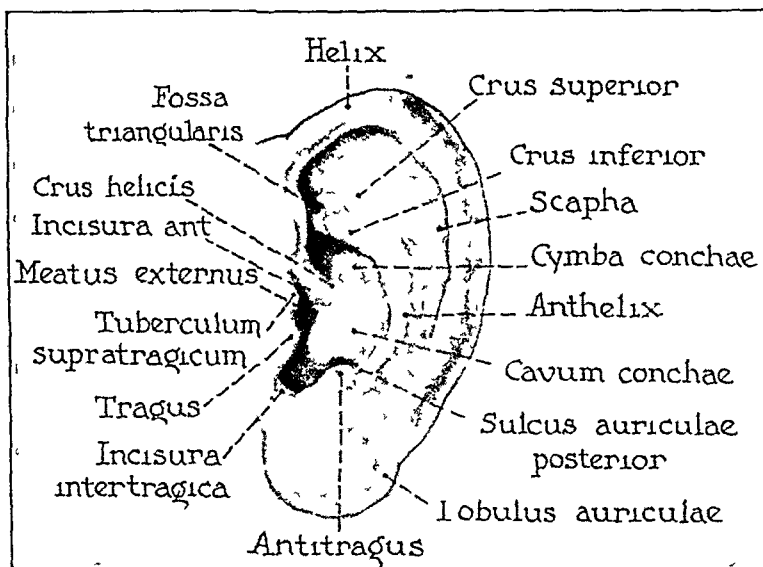


Fig 1—The normal auricle and landmarks. The rounded contour of the crus superior is noted, along with the sharper outline of the anthelix and inferior crus. In the protruding ear, the anthelix and its crura are poorly formed, and often the superior crus is absent. This factor, plus a prominent cauda helcis in many cases, accounts for the abnormally protruding ear.

whole auricle has a slight resemblance to that of a macaque monkey. This fact has caused much speculation and controversy among anthropologists, but as yet the significance of this tubercle is not clear. Another prominence, parallel with and anterior to the helix, is called the anthelix; this divides above into two crura, the superior and the inferior, between which is a shallow triangular depression, the fossa triangularis. Some authors refer to these two crura as the posterior and the anterior crus. The narrow curved depression between the

¹² Gray, H. *Anatomy of the Human Body*, edited by W. H. Lewis, ed 24, Philadelphia, Lea & Febiger, 1942.

helix and the anthelix is called the scaphoid fossa, or "boat-shaped ditch." The anthelix describes a curve around a deep cavity, the concha, which is divided into two parts by the crus, or commencement of the helix, the upper part is termed the cymba conchae, the lower part the cavum conchae. Anterior to the concha and projecting back over the external auditory meatus is a small pointed eminence, the tragus, so called from its being generally covered on its under surface by a tuft of hair, resembling a goat's beard. Opposite the tragus, and separated from it by the intertragic notch, is a small tubercle, the antitragus. Below this is the lobule, which is composed of areolar and adipose tissue. At the junction of the anthelix and the antitragus a small space exists, which may be very deep in some ears and is known as the sulcus auriculae posterior (Spalteholz¹³).

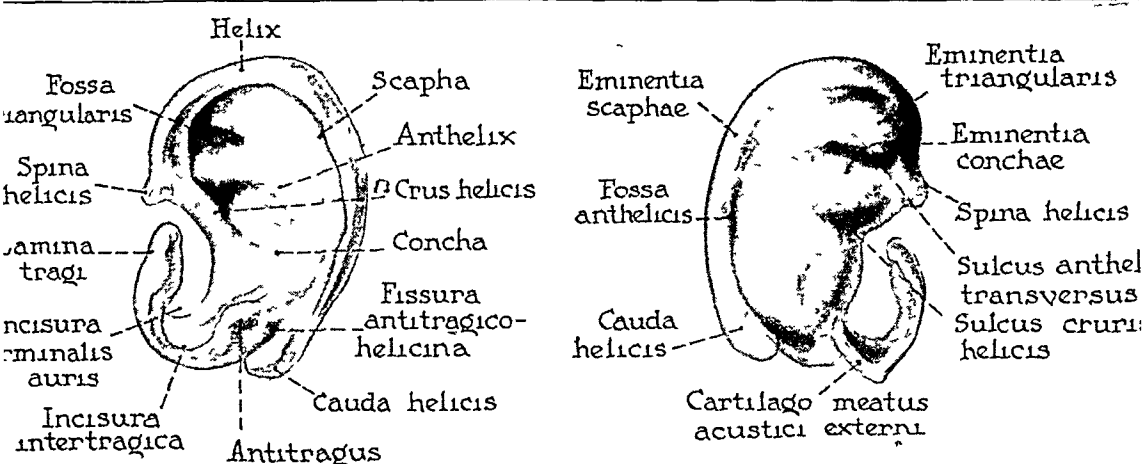


Fig 2—The normal auricular cartilage and landmarks from the anterior and the posterior surface

The auricle, with the exception of the lobe, is composed of a thin, flexible plate of yellow elastic fibrocartilage. The cartilage is 0.5 to 1 mm thick and is covered on each surface by integument intimately applied and having a minimum of subcutaneous tissue. The skin is closely adherent to the surface of the cartilage except on its posterior surface and along the helix.

The cartilage of the auricle consists of a single piece, which gives form to the ear and outlines the landmarks previously mentioned (fig 2). It is absent from the lobule and is deficient between the tragus and the beginning of the helix. At the anterior part of the auricle, where the helix bends upward, is a small projection of cartilage, called the spina helices. At the lower part of the helix the cartilage is

¹³ Spalteholz, W. Hand Atlas of Human Anatomy, Philadelphia, J. B. Lippincott Company, 1923.

prolonged downward as a tail-like process, the cauda helix, which is separated from the anthelix by a fissure, the *fissura antitragohelicina*. The cranial aspect of the cartilage exhibits a transverse furrow, the *sulcus anthelicis transversus*, which corresponds to the inferior (anterior) crus of the anthelix and separates the *eminentia conchae* from the *eminentia triangularis*. Another furrow exists at the central region of the concha, known as the *sulcus cruris helix*, which corresponds to the continuation of the helical rim and separates the concha into two portions, the *cavum conchae* and the *cymba conchae*¹³

The ligaments of the auricle consist of two sets (1) extrinsic, which connect the auricle with the side of the head, and (2) intrinsic, which connect various parts of its cartilage together and to the external auditory meatus

The muscles of the auricle likewise consist of two sets (1) extrinsic, which connect it with the skull and scalp and move the auricle as a whole, and (2) intrinsic, which extend from one part of the auricle to another. Since these muscles are rudimentary, they have no particular surgical importance. In the infraprimate mammals these muscles are particularly well developed and are important in turning the auricle toward the source of a sound.

The motor innervation is by the temporal branch and the posterior auricular branch of the facial nerve. The sensory nerves are the great auricular nerve, from the cervical plexus, the auricular branch of the vagus nerve, the auriculotemporal branch of the mandibular nerve, and the lesser occipital nerve, from the cervical plexus.

The arteries of the ear are composed of the posterior auricular, from the external carotid artery, the anterior auricular, from the superficial temporal artery, and a branch from the occipital artery. The veins accompany the corresponding arteries. The lymphatics drain into the periauricular nodes¹⁴

In examining the normal ear from behind, it will be noted that the concha forms a 90 degree angle with the head. The scapha likewise forms an angle of approximately 90 degrees with the concha, but this may vary as much as 10 to 15 degrees and still be within normal limits according to Young¹⁵. The rim of the helix is then noted to turn outward slightly. The angle between the scapha and the concha is formed by the anthelix, and in the absence or underdevelopment of the anthelix the angle may become obtuse, thereby resulting in a protrusion of the auricle away from the head. Since the angle of the anthelix more or less determines the degree of protrusion of the ear, the pathologic

¹⁴ Gray¹² Spalteholz¹³

¹⁵ Young, F. The Correction of Abnormally Prominent Ears, *Surg, Gynec & Obst* 78 541-550, 1944

condition would resolve itself into the type and development of the ant-helix, i e, the more obtuse the angle, the more the ear projects. The measurement of the angle formed by the head and the helix is known as the auriculomastoid angle and is usually about 30 degrees.

HISTORICAL DEVELOPMENT OF THE OPERATION

The earliest reference to the correction of protruding ears was made in 1845 by Dieffenbach,¹⁶ who advised the removal of skin from the back of the ear, followed by the suturing of the auricular cartilage to the periosteum of the mastoid bone.

Ely,¹⁷ of New York, is credited with being the first, in 1881, to remove both skin and cartilage for the correction of protruding ears. He excised the skin and cartilage through its entire thickness, thereby leaving a scar on the anterior surface of the auricle. Fishman and Fishman¹⁸ advised a similar procedure in 1946.

In 1890 Keen,¹⁹ of Philadelphia, reported a method of removing a narrow, V-shaped section of cartilage from the posterior surface of the auricle after a large section of skin had been excised from this area. To avoid scarring, he was careful not to cut through the anterior surface of the skin. He expressed the opinion that a section of cartilage must be removed, for "if the skin alone is removed, the natural elasticity of the cartilage would stretch the skin in time and probably reproduce the deformity."

Monks,²⁰ of Boston, in 1891 described two types of operation, one in which only the skin was excised and a second in which both cartilage and skin were removed. He stated the opinion that an excision of skin from the back of the ear would suffice in most cases and is preferable to excision of cartilage, especially if a large ellipse, "equal in breadth to more than half the breadth of the back of the ear," is removed. His reason for trying to avoid excision of cartilage was that a sharp ridge and vertical fold of skin appeared on the anterior surface of the auricle in the case in which he attempted this. However, he stated the belief that if the cartilage is stiff, a condition applying principally to adults, it is necessary to excise some cartilage, thereby substituting a disfigurement for a deformity. At about the same time,

16 Dieffenbach, J. F. *Die operative Chirurgie*, Leipzig, F. A. Brockhaus, 1845.

17 Ely, E. T. *An Operation for Prominence of the Auricles*, *Arch Otol* **10** 97-99, 1881.

18 Fishman, L. Z., and Fishman, V. P. *Plastic Surgery for Outstanding Ears: A Simple Surgical Procedure*, *Bull Pract Ophth* **16** 19-21, 1946.

19 Keen, W. W. *New Method of Operating for Relief of Deformity of Prominent Ears*, *Ann Surg* **12** 49-51, 1890.

20 Monks, G. H. *Operations for Correcting the Deformity Due to Prominent Ears*, *Boston M & S J* **124** 84-86, 1891.

in 1894, Haug,²¹ in Germany, reported the removal of triangular wedges of cartilage along with the excision of skin on the posterior surface of the auricle

Joseph,²² in 1896 and also in 1902, published a procedure similar to those described by Monks and Keen, but stated that he did so without the knowledge of these previous publications. Like Monks, he divided protruding ears into two types—the soft and the hard cartilage type. He advised that for ears of the soft cartilage type an excision of skin at the auriculomastoid angle should be sufficient, while for ears of the hard cartilage type a section of cartilage from that region would be necessary along with the excision of skin. Ballenger and Ballenger²³ advised the Joseph procedure for the correction of protruding ears.

In 1903 Morestin²⁴ published a method similar to that described by Joseph, except that one important advancement was made. Although he excised an elliptic piece of skin and cartilage from the auriculomastoid angle as Joseph and Keen did, he stated the belief that the incision through the cartilage must extend well up to the upper and lower borders of the cartilage.

Goldstein²⁵ in 1908 described an operation similar to the Morestin procedure, but he sutured the cartilage to the periosteum of the mastoid.

In 1911 Kolle²⁶ also described a method similar to that of Morestin.

He, like Morestin, stated the opinion that after the elliptic excision of cartilage at the auriculomastoid angle, a "linear incision with the scissors may be made both superiorly and inferiorly to further mobilize the springy shell of the ear, which will then be found to fall easily in place." As recently as 1947, Wolf²⁷ advised the Kolle procedure as "satisfactory in most instances."

At the same time as Morestin, in 1903, Gersuny²⁸ described a clever operation in which a skin flap is raised both from the mastoid area

21 Haug, R. Eine einfache neue plastische Methode zur Rucklagerung hochgradig abstehender Ohrmuschel, *Deutsche med Wchnschr* **20** 776, 1894

22 Joseph, J. Nasenplastik und sonstige Gesichtsplastik, Leipzig, Curt Kabitzsch, 1928, Eselsohren, *Verhandl d Berl med Gesellsch* **27** 206, 1896

23 Ballenger, W. L., Ballenger, H. C., and Ballenger, J. J. *Diseases of the Nose, Throat and Ear*, ed 9, Philadelphia, Lea & Febiger, 1947

24 Morestin, H. De la reposition et du plissement cosmetiques du pavillon de l'oreille, *Rev d'orthop* **4** 289-303, 1903

25 Goldstein, M. A. The Cosmetic and Plastic Surgery of the Ear, *Laryngoscope* **18** 826-852, 1908

26 Kolle, F. S. Plastic and Cosmetic Surgery, New York, D. Appleton & Co., 1911

27 Wolf, G. D. Ear, Nose and Throat Symptoms—Diagnosis—Treatment, Philadelphia, J. B. Lippincott Company, 1947

28 Gersuny, R. Ueber einige kosmetische Operationen, *Wien med Wchnschr* **53** 2253-2257, 1903

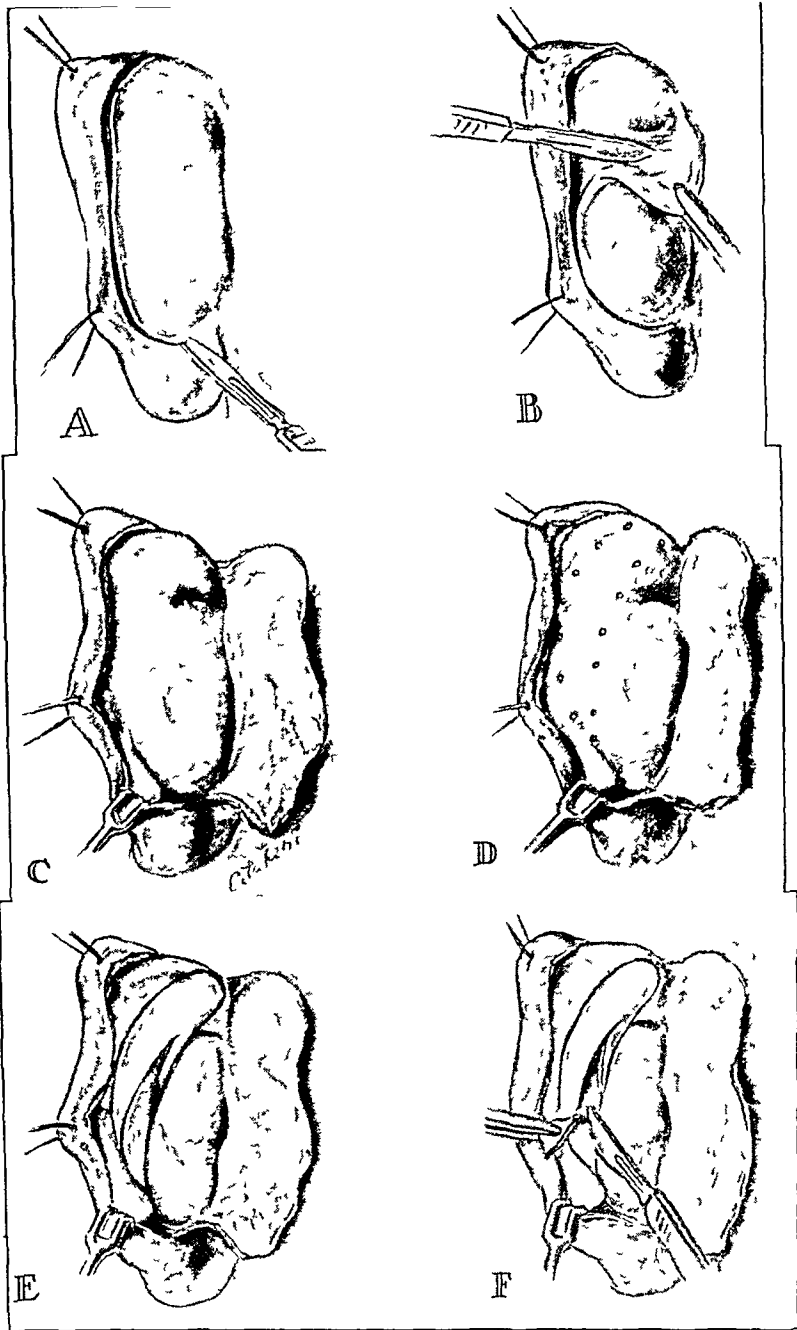


Fig 3—(A) Incision through skin and perichondrium on the posterior surface of the auricle in the region of the fossa anthelical (B) Undermining of skin and perichondrium almost to the auriculomastoid angle (C) Complete exposure of the posterior surface of auricle, revealing all landmarks, undermining of the skin anteriorly to expose the cauda helix and fissura antihelical (D) Outlining of the new anthelix and its superior crus When the ear is folded back, the new anthelix is noted on the anterior surface of the auricle The skin is then punctured through from the anterior surface with a fine needle along the outer and inner borders of the new anthelix and superior crus Each point is marked on the posterior surface of the auricular cartilage with methylene blue to delineate the cartilage incision No markings are necessary to outline the inferior crus, since the sulcus anthelical transversus is usually visible (E) Incision made along the markings down to the fissura antihelical An incision is also made through the sulcus anthelical transversus to form the inferior crus A diamond-shaped section of cartilage is then outlined, which extends up to the inferior crus (F) Section of cartilage removed The width of the excision varies with the amount of spring found in the cartilage

and from the posterior auricular surface. The cartilage of the concha is split longitudinally into ribbons, a few narrow strips are removed, and several transverse incisions are made, leaving sections of cartilage. These sections are then sutured to the periosteum of the mastoid bone, and the skin flap is then replaced and sutured. This procedure led to many similar operations in which the cartilage is sutured to the periosteum of the mastoid.

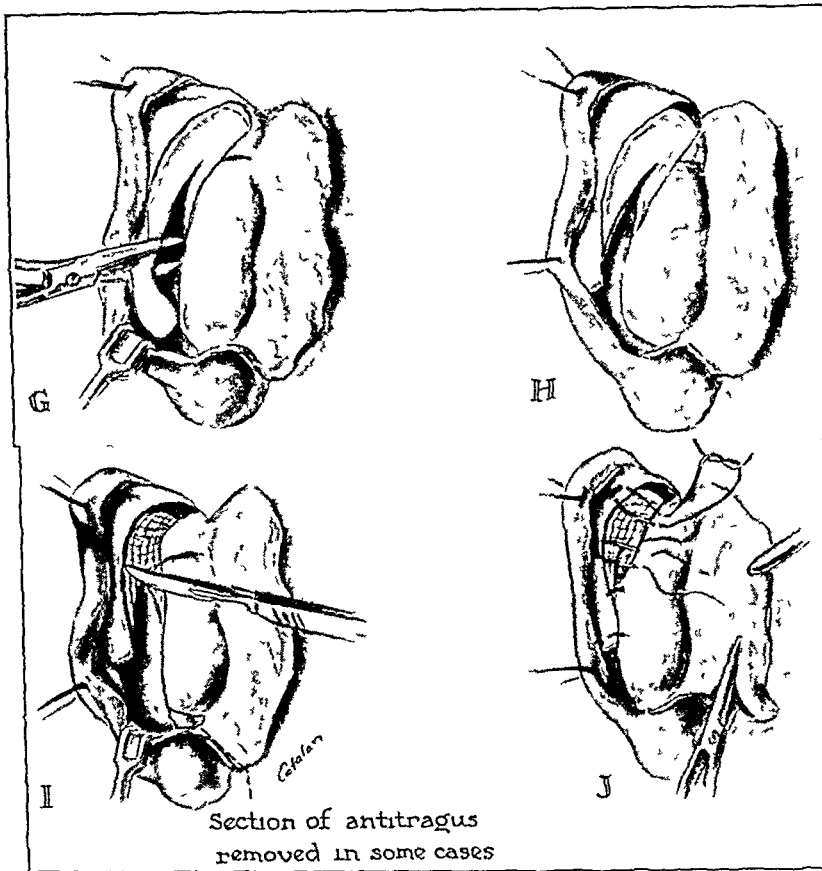


Fig 3 (continued) —(G) Cauda helix exposed and removed. This procedure is necessary in the majority of cases. An incision is made at the upper end of the superior crus for removal of a section of cartilage. This incision is located under the helix and is usually necessary to break completely the spring of the cartilage. (H) The cartilage removed. (I) Partial cross cutting of the remaining cartilage which forms the superior crus. These incisions are made to weaken the spring of the cartilage and must not pass completely through the cartilage. In cases in which the cartilage is soft or pliable, cross cutting is not necessary. In other cases, thinning of the cartilage by shaving is sufficient to weaken its spring. A section of antitragus is removed in most cases of extreme cupping of the lower portion of the ear. (J) Surgical gut fixation sutures inserted. The sutures are tied only tight enough to form a smooth anthelix and superior crus. External mattress sutures tied over cotton rolls, instead of the surgical gut sutures, have been used to good advantage in many cases. If the cartilage is soft and pliable, allowing the ear to fall back easily, no fixation sutures are necessary. Excess skin is trimmed, and black silk sutures are used to close the incision.

Following the method of Gersuny, Payr²⁹ in 1906 used a cross-shaped, pedunculated strip of cartilage and perichondrium from the entire width of the auricle and passed it under a loop of periosteum in the mastoid region. The results of this procedure were invariably poor, according to Davis,³⁰ who had tried the method. Ruttin³¹ in 1910 followed a similar plan, but used a strip of fascia lata attached to the perichondrium at the inner edge of the helix and anchored it to the bridge of periosteum over the mastoid area. Luthi³² in 1929 described a similar operation. In 1928 Alexander³³ advised a modification of these procedures. He made a longitudinal incision through skin and cartilage in the conchal region. The cartilage was then overlapped and held in position with surgical gut sutures between the cartilage and the postauricular fascia. The skin on the anterior aspect of the ear was undermined for 8 mm, evidently to eliminate the wrinkling of the skin on the anterior surface.

As late as 1935 Demel³⁴ still advised the removal of a large section of conchal cartilage, to be turned on itself and pedicled beneath a bridge of periosteum over the mastoid region.

In 1937, Eitner³⁵ recommended an operation similar to the Joseph and Morestin procedures, but tried to eliminate the wrinkling of the skin on the anterior surface by excising two triangles of cartilage with a common base from the region of the concha. The skin and perichondrium were incised horizontally and then undermined before the excision of the cartilage.

None of the procedures described can possibly result in a normal-appearing ear. The scapha projects abnormally, while the ear appears flattened against the head. On a lateral view, which is the most critical view of the ear by which to determine a good correction, the concha appears deformed in many instances, since frequently sharp ridges and excess wrinkling of the skin are noted, along with absence of the anthelix fold.

29 Payr, E. Plastische Operationen an den Ohren (Stellungsverbesserung, Verkleinerung), *Arch f klin Chir* **78** 918-928, 1906.

30 Davis, J. S. Plastic Surgery Its Principles and Practice, Philadelphia, P. Blakiston's Son & Co., 1919.

31 Ruttin, E. Eine Methode zur Korrektur absteher Ohren, *Monatsschr f Ohrenh* **44** 196, 1910.

32 Luthi, A. Eine einfache zuverlassige gut dosierbare Methode zur Korrektur absteher Ohren, *Schweiz med Wchnschr* **10** 1268, 1929.

33 Alexander, G. Zur plastischen Korrektur absteher Ohrmuscheln, *Wien klin Wchnschr* **41** 1217-1218, 1928.

34 Demel, R. Erfolge der Beseitigung der absteher Ohren, *Wien klin Wchnschr* **48** 1185, 1935.

35 Eitner, E. Eine einfache Methode zur Korrektur absteher Ohren, *Wien klin Wchnschr* **50** 1206 1937.

The basic concept for the newer type of otoplasty was first described by Luckett,³⁶ who in 1910 pointed out that the reason for protruding ears was the absence or underdevelopment of the anthelix. If a new anthelix were made, the prominence of the ear could be overcome, furthermore, on a lateral view a more normal-appearing ear would result without the distortions of the concha and absence of the normal anthelix fold. Luckett's operation consisted of the removal of a crescentic area of cartilage and skin from the posterior surface of the auricle over the line of the proposed anthelix, the edges of cartilage were everted by the use of a Lembert suture, thereby forming a new anthelix.

Davis,⁴⁰ in 1919 and again in 1937,⁸ emphasized the basic concepts of Luckett, they also served as the basis for Barsky's³⁷ operation in



Fig 4—Unilateral protrusion of the ear with associated mandibular deformity. Protrusion of the ear was corrected by the method described, and the facial deformity, by a thoracicoepigastric pedicle skin graft and an iliac bone graft to the mandible.

1938 Davis and Kitlowski in 1937,⁸ published a method they had been using for correction of protruding ears, based on the concepts of Luckett. They outlined the new anthelix along the inferior (anterior) crus with brilliant green introduced by needle through perforations in the skin with a needle from the anterior surface of the auricle. The skin on the posterior surface of the auricle which had been removed both from the conchal and from the mastoid region was discarded. The cartilage was split along the previously marked line and a section

³⁶ Luckett, W. H. A New Operation for Prominent Ears Based on the Anatomical Deformity, *Surg, Gynec & Obst* 10 635-637, 1910

³⁷ Barsky, A. J. *Plastic Surgery*, Philadelphia, W. B. Saunders Company, 1938

removed. The authors emphasized that the cartilage must be split through the entire length of the proposed anthelix to break its elasticity. Surgical gut sutures closed the perichondrium, and the edges were everted to form the new anthelix.

The objection to the Davis-Kitlowski procedure is that the normal postauricular sulcus is obliterated by the excessive removal of skin from the posterior surface of the auricle and from the mastoid region. Also, in the removal of cartilage only from the inferior crus, the superior



Fig 5—Protruding ears corrected by the standard method of excision of cartilage. Note that the corrected ears are properly placed in relation to the head, but in the lateral view a sharp ridge is present in the region of the superior crus. This gives the ear an unnatural appearance. (A rhinoplasty was performed at the same time that the ears were corrected.)

crus may appear flat, and at times the ear will appear to lop forward at its upper pole.

The Davis-Kitlowski procedure led to a modification by New and Erich³⁸ in 1940, who used mattress sutures externally to help hold

38 New, G. B., and Erich, J. B. Protruding Ears. A Method of Plastic Correction, *Am J Surg* 48:385-390, 1940.

the form of the new anthelix. They also excised cartilage from the inferior crus, but at times felt it necessary to remove a wedge of cartilage from the superior (posterior) crus to prevent the upper pole of the ear from falling forward. New and Erich cited Webster as stating that he had satisfactory results without incising the cartilage, merely shaving the cartilage in the region of the anthelix. New and Erich, however, stated the belief that the ear can be folded back with greater ease if a narrow strip of cartilage is excised.

Weaver,³⁹ in 1947, described the use of the New and Erich procedure and stated that he had found it a highly satisfactory method. His experience was based on 8 cases.



Fig 6—Bilateral protrusion of the ears, most marked at the upper pole. The angle of the anthelix is obtuse, accounting for the protrusion of the ear. The normal angle of the anthelix is from 80 to 100 degrees. The formation of a normal anthelix by the method described, with very little sacrifice of skin from the posterior region of the auricle, results in an ear which satisfactorily simulates the normal.

Young¹⁵ in 1944 described a method similar to but an improvement on the Davis-Kitlowski procedure. He stated the opinion that if the section of cartilage forming the new anthelix were removed correctly the scapha could be slipped over the concha, and thereby no external mattress or internal surgical gut sutures would be needed to hold the new fold of the anthelix. The excision of cartilage was made

³⁹ Weaver, D F. Correction of Prominent Ears, *Arch Otolaryng* **45** 205-208 (Feb) 1947

in the region of the superior (posterior) crus rather than in the inferior crus, though Young expressed the belief that an incision is necessary in the inferior crus at times. No skin, other than the excess, is sacrificed from the postauricular sulcus.

Young's procedure is a decided improvement over the Davis-Kitlowski method, for two reasons. 1 The main excision of cartilage is from the superior crus, the ear thus has a better appearance. 2 No skin is sacrificed from the postauricular sulcus, thereby the ear is prevented from appearing too close to the head. The objections to Young's method are that a sharp ridge is produced in the region of the superior crus (fig 5) and no provision is made for extreme cupping or protrusion of the lower pole of the ear.



Fig 7—Marked protrusion and cupping of the ears corrected by the method described. The preoperative photographs show complete absence of the anthelix and its superior crus. The inferior crus is present but not well defined. It was necessary to remove a section of antitragus after the removal of the cauda helix in order to set the lower portion of the ear back to its proper position.

Barsky³⁷ in 1938 presented an excellent operation, based also on Luckett's principles, in which he excised a narrow triangular section of cartilage in the region of the proposed new anthelix. The base of the triangle was about $\frac{1}{16}$ to $\frac{1}{8}$ inch (0.16 to 0.32 cm) in width, and the apex came to a point at the perichondrium on the anterior surface. Two curved incisions were made parallel to this one on either side, and the cartilage was thinned by being shaved with a knife. Surgical gut sutures were inserted through the perichondrium to unite the two incisions and thereby form an anthelix. Barsky stated the belief that it might be necessary to excise a small ellipse of cartilage from the base of the concha.

In 1947 McEvitt⁴⁰ described a method similar to that used by Young. He advised the excision of cartilage at the anthelix and its crura, and in some cases the placement of parallel incisions further to break the spring of the cartilage. He emphasized the necessity in some cases of excising part of the antitragus and crosscutting the remaining portion, a detail which most reports fail to mention in correction of the extremely cupped type of ears. He stated that in correcting some of the simpler types of protruding ears he has lately tended to remove less and less cartilage, and at times none.

MacCollum,⁴¹ in 1938, Coe,⁴² in 1942, Seeley,⁴³ in 1946, and Seltzer,⁴⁴ in 1947, described operations similar to the Luckett, Young and Davis-Kitlowski methods, except that they varied the excision of the cartilage.

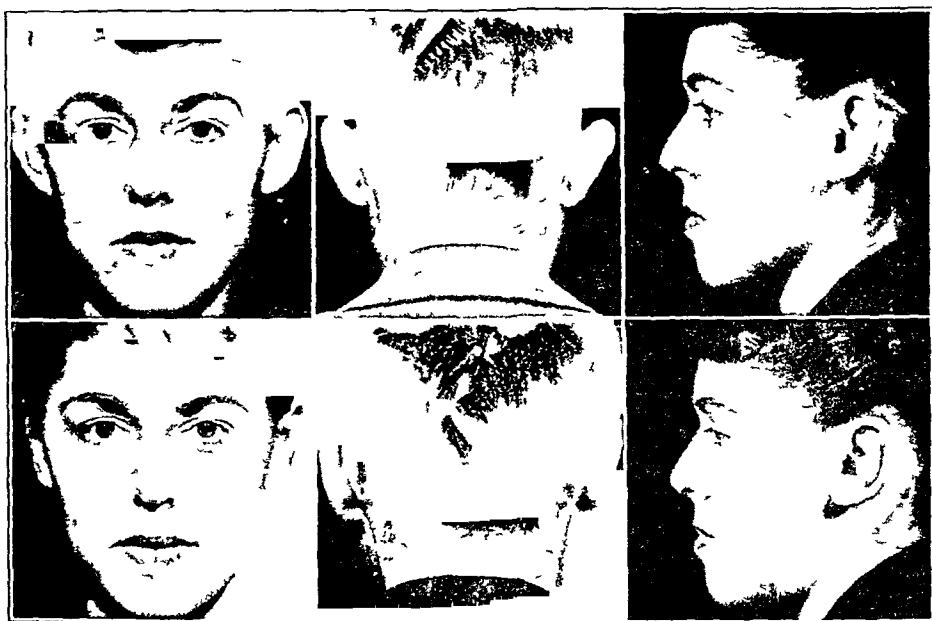


Fig 8—Protruding ears corrected by the method described. The corrected ears present a normal contour of the anthelix and superior crus in lateral view and a normal auriculomastoid angle in the posterior view.

Pierce, Klabunde and Bergeron⁴⁵ reported a procedure for correction of protruding ears by making eight to ten incisions almost

⁴⁰ McEvitt, G. The Problem of the Protruding Ear, *Plast & Reconstruct Surg* 2 481-496, 1947.

⁴¹ MacCollum, D. W. The Lop Ear, *J. A. M. A* 110 1427-1430 (April 30) 1938.

⁴² Coe, H. E. Correction of Lop Ears, *Northwest Med* 41 126, 1942.

⁴³ Seeley, R. C. Correction of the Congenital Protruding Ear, *Am J Surg* 72 12-15, 1946.

⁴⁴ Seltzer, A. P. The Importance of Correcting Outstanding Ears, *Ann Otol, Rhin & Laryng* 58 1012-1020, 1947.

⁴⁵ Pierce, G. W., Klabunde, E. H., and Bergeron, V. L. Useful Procedures in Plastic Surgery, *Plast & Reconstruct Surg* 2 358-361, 1947.

through the cartilage. They stated the belief that the older operations leave a prominent ridge on the anterior surface of the auricle and that this new method gives an accurate representation of the normal fold. Five surgical gut sutures are used to hold back the anthelix fold and the ear. Excess skin is removed and the remaining skin is sutured with dermalon®. This procedure, with Barsky's method, is a significant advance over the older procedures in which sections of cartilage are removed, for these methods allow for a smooth, and not a sharp, superior crus of the anthelix, thus simulating the normal ear. However, in my experience, these procedures are applicable only to the very slight, or simple, type of protrusion.

The fact that so many different procedures have been described for the correction of protruding ears leaves the impression that no one ideal method has been found. At times it is necessary in certain types of ears to use a variety of methods, since no one procedure will suffice for the entire correction. However, the method to be described, with the variations which are outlined for different types of protrusions, quite accurately reproduces the normal auricle with almost uniform success (figs 4, 6, 7 and 8).

OPERATIVE TECHNIC

The hair is shaved for a distance of 1 inch (2.5 cm) from the ear and is held away from the operative field with a head towel and strips of adhesive tape. The ears are thoroughly washed with soap and water, followed by application of an antiseptic solution. With the patient lying on his back, the head is draped, and only one ear is exposed at a time. A comparison of the two ears is usually unnecessary during the operation, since one can judge fairly accurately when the ears are evenly placed to the head.

Children are anesthetized by the endotracheal method with ether or gas, adults, by local infiltration of procaine hydrochloride, 1 per cent, with epinephrine hydrochloride, 1:5,000, after preoperative analgesia with morphine and barbiturates. A complete encirclement of the ear is made with applications of the procaine, and additional solution is infiltrated on the posterior surface and on the anterior surface of the anthelix, the injections in the latter two regions being primarily to facilitate the dissection and for hemostasis.

An incision through the skin and perichondrium is made on the posterior surface of the auricle in the region of the margin between the scapha and the concha, i. e., in the fossa anthelica, and is extended at the superior portion to the junction of the ear and the temporal region, while at the inferior portion it is extended down to the base of the antitragus, close to the mastoid region. The skin and perichondrium are then undermined laterally almost to the auriculo-mastoid angle and to the beginning rim of the helix, thereby exposing the whole posterior surface of the auricular cartilage and all its landmarks (fig 3 A, B and C).

The following landmarks are exposed on the posterior surface of the auricle: (1) the entire region of the concha and scapha, which is necessary to the outlining of the new anthelix and its superior crus, (2) the sulcus antihelica transversus, which corresponds to the inferior crus of the anthelix, (3) the fissura antitrago-helica, which separates the cauda helica from the antitragus, (4) the cauda

helicis in its entirety, (5) the conchal furrow or fissure formed by the portion of the helix which divides the concha into cymba and cavum, known as the sulcus cruris helicis, and (6), in some cases of cupped protruding ears, the antitragus (fig 2)

If the ear is folded back against the head, the new anthelix is noted on the anterior surface of the auricle. The skin and cartilage are then punctured through from the anterior surface with a fine needle, and each point is marked on the posterior surface of the auricular cartilage with methylene blue to outline the incision in the cartilage. The double row of marks resulting from this maneuver are so placed that they completely delineate the posterior and anterior borders of the anthelix and its superior crus. At the upper end, the markings converge to a curved apex in the region of the superior crus of the anthelix as it merges with the helix. The inferior border comes to a point at the fissura antitragohelicina (fig 3D)

Two incisions are made through the cartilage, one along each of the markings (fig 3E). A section of cartilage is then removed from the anthelix. This excision starts at the fissura antitragohelicina and continues to an apex at the sulcus anthelicis transversus, so that a diamond-shaped piece of cartilage is removed (fig 3F). The size of the excision of cartilage depends on the amount of spring which must be overcome and ranges at its widest point from 6 to 9 mm. The skin is then undermined laterally for a few millimeters on the anterior surface of the auricle. No cartilage is removed from the superior crus.

The sulcus anthelicis transversus, which corresponds to the inferior crus, is easily located and is then incised completely through. The incision extends into the previously incised cartilage of the anthelix. It will break the spring of the inferior crus, and rarely is the removal of a wedge or cross cutting of this region necessary (fig 3E).

The cauda helicis, which has already been exposed, is then completely removed (fig 3G and H) unless the deformity is completely confined to the upper portion of the ear, in which case removal may not be necessary. However, in my experience it has been necessary in almost all cases either to remove or to break the spring of the cauda helicis by cross cutting, for in most cases there are prominence and cupping of the lower portion of the ear with a projection upward of the ear lobe. Since removal of the cauda helicis does not cause any distortion of the auricle on the anterior surface, it has proved advantageous in most cases to remove it.

The superior crus is then cross cut by incisions, which do not completely pass through the cartilage (fig 3I). The purpose in incomplete cross cutting of the cartilage at the superior crus is to weaken the spring of the cartilage and thereby help to give it a rounded contour, since normally the superior crus of the anthelix presents a smooth, rounded surface. This rounded contour becomes evident after the sutures are inserted. Since the lower portion of the anthelix usually presents a sharper edge, it is permissible to remove a section of cartilage from that region. When cartilage is removed from the superior crus, it leaves a very sharp ridge on the anterior surface of the auricle, which is unnatural in appearance (fig 5).

In many cases it is not necessary to cross cut the cartilage, especially in the ears of children, in which the cartilage is soft and pliable and will bend into position after the insertion of the fixation sutures. In other cases thinning down of the cartilage by shaving is sufficient to weaken its spring.

A small transverse section of cartilage is now removed from the upper end of the superior crus, at its junction with the helix (fig 3G and H). This is necessary to break completely the spring of the anthelix and superior crus from its attachment to the cartilage of the helix. If this section of cartilage is removed

close to the helix, no visible fold or defect will be seen on the anterior surface of the superior crus, since it is hidden under the rim of the helix

In cases in which severe cupping and projection of the ear lobe and lower portion of the ear have not been completely corrected by excision of the cauda helix, the antitragus is exposed and cross cut, or a strip of cartilage is removed from the under surface of the antitragus. Removal of a section of antitragus from its under surface leaves no deformity on the anterior surface of the auricle (fig 3 I)

In some instances, when the concha itself is also involved in the protrusion of the ear, it may be necessary to cross cut or to shave a section of cartilage at the fissure which is present in the concha. This fissure, which is formed by a continuation of the helix, is the sulcus cruris helix, and it separates the concha into two portions, the cymba and cavum. Many normal ears have a prominent elevation on the anterior surface in this region, therefore cross cutting or shaving of the cartilage here will not cause an abnormal fold

Three or four surgical gut (mattress type) sutures are inserted through the perichondrium along the margins of the original incisions in the cartilage and are tied just tightly enough to form the new anthelix fold (fig 3 J). In many cases external mattress type sutures tied over cotton rolls, as suggested by New and Erich,³⁸ were used instead of the internal surgical gut fixation sutures. In most cases the sutures proved to have a definite advantage over the internal surgical gut fixation sutures in formation of the anthelix and superior crus. In other cases, in which the cartilage is soft and pliable, or in which the protrusion is not too pronounced, no internal or external fixation sutures are necessary

A section of the excess skin is removed from the posterior surface of the auricle (fig 3 J), and the margins of the skin are closed with interrupted fine black silk sutures. Sterile wet cotton or rubber sponges are placed in the convolutions of the ear on the anterior surface, and a fairly snug pressure bandage is applied. The bandage is left untouched for six days, after which the ears are inspected and rebandaged, if external mattress sutures were used, they are removed at this time. On the ninth day the skin sutures are removed, and a light mastoid type bandage is reapplied for a period of four or five days. The patient is then instructed to wear a tight-fitting silk stocking cap at night for one week

CONCLUSION

With the method described, a protruding ear can be properly reconstructed to simulate the normal. The anthelix fold is reformed so that it has normal contours. No sharp ridges or projections are formed, such as are usually present when cartilage is removed from the superior crus. The ear is set back to the head at the proper angle, and the postauricular sulcus is not obliterated, as in the procedures in which large sections of skin over the mastoid area and the auricle are removed. The concha appears normal, and there is no wrinkling of skin on the anterior surface of the auricle. The whole lower pole and lobe of the ear are set back by removal or cross cutting of the cauda helix, and, when necessary, by removal of a section of cartilage from the under surface of the antitragus. By the wide exposure of the posterior surface of the auricle, all landmarks are readily identified for correction of the deformity

ANESTHESIA IN PERORAL ENDOSCOPY

Especially General Anesthesia in Esophagoscopy and Gastroscopy

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THE MAJORITY of peroral endoscopic examinations can be made with local anesthesia or without anesthesia without a great deal of discomfort to the patient and with satisfactory operative results. Use of local anesthetic agents is attended with a minimal amount of risk, but alarming and sometimes fatal reactions may follow their application.

The comparative risk involved in local and general anesthesia is debatable, and the choice of an anesthetic agent cannot be made on the basis of risk alone. Except under unusual conditions and for solution of especially troublesome problems, we have found that bronchoscopic examination should be made in small children without anesthesia and in adults with local anesthesia.

Employment of sedatives preoperatively is usually advisable in case of children. In case of adults, administration of barbiturates preoperatively lessens the likelihood of reaction to local anesthetics, but it is not desirable to use so much sedation that the patient is rendered uncooperative.

There are many reasons for recommending that bronchoscopic examination be done without anesthesia or with local anesthesia. Continuous inhalation anesthesia is difficult to administer if examination is prolonged, and varying degrees of relaxation are a source of annoyance to the examiner. Regulation of the cough reflex is impossible in a patient under inhalation anesthesia, and much valuable information is unobtainable at bronchoscopic investigation unless cough is voluntarily controlled or produced. When the cough reflex is reduced or abolished, excessive secretion or blood is usually more difficult to evacuate from the tracheobronchial tree and may lead to pulmonary complications if recovery from anesthesia is prolonged. Intravenous anesthesia is objectionable in bronchoscopic study for the reasons that make inhalation anesthesia undesirable. In addition, respiration is greatly depressed by the agent and, because of inhibitory reflexes, may be suspended

entirely for a long period following introduction of the bronchoscope. In such circumstances the bronchi are frequently observed only in a state of extreme expiration, with the lumens greatly reduced in size.

In contrast to bronchoscopic study, we have found that esophagoscopy and gastroscopic investigations can be performed more easily, safely and comfortably with the patient under some type of general anesthesia, supplemented in most cases by introduction of an intratracheal tube.

Introduction of an esophagoscope into the esophagus of a child less than 3 years of age without anesthesia or under inhalation anesthesia results in pressure on the trachea and larynx, which, combined with associated spasm of the vocal cords, is usually sufficient to interfere with breathing. If examination requires more than a few moments, respiration may cease and the tube must be withdrawn and respiratory function reestablished. When one is pressed for time in such instances, hurried instrumentation may add to the risk of the operative procedure.

When prolonged investigation is anticipated, we recommend introduction of an intratracheal tube, which obviates respiratory difficulty during examination and permits continuous, even anesthesia. This procedure is particularly desirable when removing an open safety pin from the esophagus of a small child.

Children are put to sleep with vinyl ether U S P (vinethene®) and ether by the open drop method, and after intratracheal intubation anesthesia is maintained according to Ayre's technic, which eliminates resistance and retention of carbon dioxide. Although some evidence of laryngeal obstruction following bronchoscopic manipulation might be expected to develop in a relatively large percentage of very young children, this complication has not been found to occur after intubation with a firm rubber or plastic endotracheal tube.

In adults, intravenous anesthesia with thiopental sodium U S P (pentothal sodium®) combined with curare is applicable in most cases. An important adjunct in the technic is to apply a local anesthetic in the larynx and to instill a small amount of the anesthetic drug into the trachea. This local, preliminary anesthesia will obtund many reflexes and reduce the amount of thiopental required. An endotracheal tube is then introduced for administration of oxygen. In this way respiration may be completely controlled, and esophagoscopy or gastroscopic manipulation may be performed with ease for the examiner and the patient. The relaxation of the esophagus thus obtained is particularly desirable in removal of large foreign bodies when tenseness of the patient under local anesthesia would increase the likelihood of trauma.

Employment of intratracheal intubation is especially desirable in complete obstruction of the esophagus with retention of secretion when

ordinary inhalation anesthesia is contraindicated because of the danger of aspiration into the tracheobronchial tree. Intratracheal intubation provides an ideal method for removal of a bolus of meat from the esophagus, since this procedure usually requires prolonged instrumentation and is, therefore, especially uncomfortable for the patient under local anesthesia.

Gastroscopic investigation is usually performed with local anesthesia, but many examinations are unsatisfactory because of distress to the patient and inability to maintain inflation of the stomach with air. Intravenous use of thiopental sodium with local anesthesia and insertion of an intratracheal tube provide opportunity for prolonged study of the stomach without distress to the patient and without the changes in appearance of the gastric mucosa that may result from emotional reactions.

Adequate anesthesia that can be prolonged indefinitely provides an ideal situation for teaching, in that any number of students may observe lesions in the stomach and esophagus without compromising the welfare of the patient.

In our experience, presence of an intratracheal tube does not interfere with introduction of tubes into the esophagus. Recovery from anesthesia is prompt and postoperative discomfort less than after examination with local or inhalation anesthesia.

MÉNIÈRE'S SYNDROME

Observations on Vitamin Deficiency as the Causative Factor

II The Cochlear Disturbance

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THE FIRST PART of this communication was concerned with the acute phase of Ménière's syndrome—the vestibular disturbance or attacks of vertigo¹. The second part deals with the cochlear disturbance—the deafness and tinnitus—which persists between the acute attacks, or the chronic phase.

In considering the acute phase it was pointed out that clinical observations of 87 consecutive patients with Ménière's syndrome showed them to have signs of chronic vitamin deficiency, often of severe degree, that the two groups into which patients with this syndrome have so far been divided by means of the histamine skin test present different predominating deficiencies, the histamine-negative group showing a predominant niacin deficiency and the histamine-positive group a predominant riboflavin deficiency, that the type of vertigo experienced by the two groups is not the same, and, finally, that there must now be recognized a third group giving an intermediate response to histamine intradermally and showing a mixed deficiency and a mixed clinical picture.

The present paper records the observations made on the clinical features of the chronic phase as regards these three groups and the vitamin deficiencies associated with them, and the results of treatment.

MATERIAL AND PROCEDURE

The material was the same as that used in part I, viz, 87 consecutive cases of the classic Ménière's syndrome, which have been investigated from the standpoint of deficiency of the three major components of the B complex (niacin, riboflavin and thiamine) during the twenty-one months from March 1946 through November 1947.

The procedure for each patient was also the same as in part I.

1 To record the response to standard doses of histamine diphosphate administered intradermally under standard conditions as described elsewhere².

1 Atkinson, M. Ménière's Syndrome. Observations on Vitamin Deficiency as the Causative Factor, I The Vestibular Disturbance, *Arch Otolaryng* **49** 151 (Feb) 1949.

2 Atkinson, M. Ménière's Syndrome. The Validity of the Intradermal Histamine Test, *Ann Otol, Rhin & Laryng* **54** 801 (Dec) 1945.

2 To determine the type of deafness from which each patient suffered and to record the type or types of tinnitus of which he complained

3 To keep a chart of those symptoms generally accepted as accompanying certain vitamin deficiencies (fig 1)

4 To make a corresponding examination, noting signs of niacin deficiency in the tongue, of riboflavin deficiency in the eyes, the lips, the skin of the face

CASE SHEET FOR NUTRITIONAL DEFICIENCIES

VITAMIN A	RIBOFLAVIN— <i>continued</i>
Night blindness	Corneal scarring
Hyperkeratosis	Pinguecula
	Vertigo, positional
	Headache
THIAMINE	
Anorexia	
Constipation	NIACIN
Loss of weight	Tongue
Paresthesias	Abdominal tenderness
Muscular tenderness	Anorexia
Fatigue	Diarrhea
Loss of tendon reflexes	Dermatitis
Palpitations	Mental depression
Tachycardia	Mental confusion
Cardiac enlargement	Loss of memory
	Headache
	Vertigo, rotational
	"Feel the cold"
RIBOFLAVIN	
Magenta tongue	ASCORBIC ACID
Cheilosis	Gums
Angular stomatitis	Joints
Seborrheic dermatitis	Hemorrhages
Photophobia	Weakness
Lacrimation	Recent infection
Eye strain	
Corneal vascularization	

Fig 1—Case sheet for recording nutritional deficiencies

and in the tongue, of thiamine deficiency in disturbances of function of the nervous system as shown by hyperreflexia or hyporeflexia

5 To record by means of photographs the appearances of the organs mentioned in paragraph 4

6 To treat each patient as far as possible with the particular fraction appropriate to his group, and with that alone in the first place, and to observe and record the results of such treatment

The results of these investigations will be described in two sections, one relating to deafness and the other to tinnitus

DEAFNESS

METHOD OF EXAMINATION

1 The degree of hearing impairment was determined when the patient was first seen, by an audiometric reading in a quiet room with an average noise level of 40 decibels. Additional audiograms were made from time to time as seemed advisable, by the same operator in the same room with the same audiometer.

2 The type of hearing impairment was determined by tuning fork tests. The tests used have been the Rinne test, the absolute bone conduction test and tests to determine high and low tone limits. The first two tests have been made with a C 256 fork, and the high tone limit was determined with a Galton whistle.

3 Masking. The validity of the audiometric reading and of the results of the Rinne test and the absolute bone conduction test of the affected ear was checked by masking the normal or better ear with a sound box.

4 Grouping. Cases have been divided with regard to types of hearing loss into the conventional three groups—perceptive, conductive and mixed. Criteria for the pure perceptive group were a positive Rinne test, diminished absolute bone conduction, a lowered high tone limit and a normal low tone limit. Criteria for the pure conductive group were a negative (reversed) Rinne test, normal absolute bone conduction, a raised low tone limit and a normal high tone limit. Criteria for the mixed group were either (1) a hearing loss of predominantly nerve type but with diminished air conduction and a raised low tone limit, or (2) a hearing loss of predominantly conductive type but with diminished absolute bone conduction and a lowered high tone limit.

RESULTS OF EXAMINATIONS

The results of the examinations are shown in tables 1 and 2. One hundred and twenty-three ears with impairment of hearing were found in the 87 patients investigated. The cases of hearing loss have been divided into three categories according to the patient's response to the histamine skin test, as was done in part I. In table 1 is shown the number of cases of each type of hearing loss which have fallen into that category, and table 2 shows the severity of the impairment in each category in terms of decibel loss, determined by averaging the losses for the four frequencies 256 to 2048.

1 Perceptive deafness. This type of hearing loss is generally considered to be the usual, indeed the almost exclusive, type associated with Meniere's syndrome. In this series of 123 affected ears, impairment of purely perceptive type was present in only 62 (50 per cent), the incidence being practically equally distributed proportionately among the three histamine groups. If to these are added the 33 cases of mixed deafness in which perceptive deafness predominated (see paragraph numbered 2), there are 95 cases (77 per cent) in which the type of impairment was purely or predominantly perceptive.

2 Mixed deafness. This type was found in 52 ears (43 per cent). The distribution is interesting. Half of the cases were found in the intermediate histamine group, the group showing mixed deficiency,

TABLE 1—Types of Deafness According to Histamine Groups

Group	Perceptive Deafness	Mixed Deafness	Conductive Deafness	"Dead" Ears	Total
		P + C C + P 10 (41%) 2 (9%)			
Vasoconstrictor Histamine — 20 cases, 24 ears Niacin deficiency	12 (50%)	12 (50%)	0	0	24
Intermediate Histamine ± 43 cases, 64 ears Mixed deficiency	32 (50%)	13 (20%) 13 (20%) 26 (40%)	3 (5%)	3 (5%) (1 post op)	64
Vasodilator Histamine + 24 cases, 25 ears Riboflavin deficiency	18 (51%)	10 (29%) 4 (11%) 14 (40%)	2 (6%)	1 (3%)	35
Total (ears)	62 (50%)	33 (27%) 19 (16%) 52 (43%)	5 (4%)	4 (3%)	123

Bilateral Cases *

Vasoconstrictor group	4 (20%)
Intermediate group	22 (52%)
Vasodilator group	11 (46%)

TABLE 2—Severity of Deafness According to Type and Histamine Group

Group	Perceptive Deafness				Mixed Deafness								Conductive Deafness				"Dead" Lars	Total
	0—20	40—60	Over 60		P + C				C + P				0—20	40—60	Over 60			
					0—20	40—60	Over 60		0—20	40—60	Over 60							
Vasoconstrictor Histamine — 20 cases, 24 ears Niacin deficiency	1	5	1	5	0	2	5	3	0	0	2	0	0	0	0	0	0	24
	12 (50%)				10 (41%)				2 (9%)				0				0	
Intermediate Histamine ± 43 cases, 64 ears Mixed deficiency	6	17	7	2	0	2	6	5	0	2	8	3	0	0	2	1	3 (5%)	64
	32 (50%)				13 (20%)				13 (20%)				3 (5%)				3 (5%)	
Vasodilator Histamine + 24 cases, 35 ears Riboflavin deficiency	2	11	4	1	0	0	4	6	0	1	2	1	0	0	2	0	1 (3%)	35
	18 (51%)				10 (29%)				4 (11%)				2 (6%)				1 (3%)	
Total	9	33	12	8	0	4	15	14	0	3	12	4	0	0	4	1	4 (3%)	123
	62 (50%)				33 (27%)				19 (15%)				5 (4%)				4 (3%)	

the other half were about equally divided between the vasoconstrictor and vasodilator groups. When these 52 cases were analyzed more carefully by dividing them according to two subtypes—one in which perceptive deafness predominated, and one in which conductive deafness predominated—it was found that perceptive deafness predominated in the 12 ears in the vasoconstrictor group by 10 to 2, and in the 14 ears in the vasodilator group by 10 to 4, while the 26 ears in the intermediate histamine group were equally divided, 13 to 13, as to predominant type. Thus perceptive deafness predominated in 33 cases and conductive deafness in 19 cases.

3 **Conductive deafness** A pure type of conductive deafness was found in 5 ears (4 per cent). Of these, 3 were in the intermediate histamine group and 2 in the vasodilator group. (There were no cases of pure conductive deafness in the vasoconstrictor group.) If to these 5 cases of pure conductive deafness are added the cases of mixed deafness in which conductive deafness predominated, conductive deafness, in some degree, has been present in 24 ears (20 per cent)—in 2 out of 24 ears in the vasoconstrictor group (8 per cent), in 6 out of 35 ears in the vasodilator group (17 per cent) and in 16 out of 64 ears in the intermediate histamine group (25 per cent).

It thus appears that hearing loss of conductive type, or at least some element of it, occurs a good deal more frequently than is generally appreciated, that its incidence is preponderantly in the vasodilator and intermediate histamine groups, that is to say in the two groups in which riboflavin deficiency predominates, and that its incidence is small in the vasoconstrictor group in which niacin deficiency predominates.

4 **"Dead" ears** There were 4 "dead" ears in the series, 1 e, ears which did not respond to the cold caloric test or to the audiometric test with the good ear masked, 3 were in the intermediate group, 1 in the vasodilator group. Of these, 1 (in the intermediate group) was the result of a total section of the eighth nerve of the ear which was believed at the time to be the operative ear, though subsequently the opposite ear became severely affected, with great and rapid loss of hearing and a recurrence of attacks of vertigo. Of the other 3 ears, 1 had normal hearing before the onset of vertigo but hearing then began to deteriorate rapidly and in a few months was completely abolished. At no time has there been any neurologic evidence suggestive of an acoustic tumor and all symptoms except deafness and tinnitus have gradually subsided and disappeared under treatment. The other two experienced sudden and complete loss of hearing coincident with the first attack of vertigo, a loss which has been permanent.

5 Bilateral impairment By definition the classic Meniere's syndrome demands that the hearing loss be unilateral or predominantly unilateral. However, bilateral, though unequal, involvement is far from uncommon—in this series of 87 cases 37 (43 per cent) showed involvement of both ears. The distribution in groups was vasoconstrictor group, 4 (20 per cent), vasodilator group, 11 (46 per cent), intermediate group, 22 (52 per cent). In other words, bilateral involvement is considerably more common in the two groups which show marked or predominant riboflavin deficiency than in the group showing predominant niacin deficiency.

6 Absence of bone conduction In the course of examining for absolute bone conduction as described, *i. e.*, with a C 256 tuning fork and the opposite ear masked with a noise box, 18 cases have been observed in which hearing by bone conduction was absent in the affected ear, though hearing by air conduction was retained, 10 were cases of perceptive deafness, 8 were cases of mixed deafness predominantly perceptive. In all these the impairment was severe—in 7 there was a loss of 40 to 55 decibels, and in 11 a loss of 60 decibels or more. Nine cases belonged to the vasoconstrictor group, 7 to the intermediate histamine group and 2 to the vasodilator group.

THERAPEUTIC METHOD

The method of treatment has been the same as described in part I, *i. e.*, at first intensively by intravenous injection together with oral administration, later by long-continued, high dosage oral administration alone. Members of each group were treated with the appropriate vitamin fraction, and so far as possible with that alone, until satisfactory evidence of its effect had been obtained. Members of the vasoconstrictor group received nicotinic acid, members of the vasodilator group riboflavin, members of the mixed group first one and then the other. However, it has not been possible to use individual fractions to the same extent that it was in dealing with the acute phase. The vestibular disturbance can usually be brought under control within a few weeks at most, given intensive treatment and adequate dosage, and it was thus possible in treating patients for the acute phase to concentrate on one fraction and observe its effect. The cochlear disturbance constituting the chronic phase is more difficult to control, improvement, when it does occur, may not be evident for some months, and it is seldom advisable to continue exhibiting one fraction alone for such long periods for fear of precipitating severe vitamin imbalance (see part I, cases 1 and 2). Nevertheless, even though in most cases all three main fractions were used after the acute phase had been brought under control, emphasis was still placed on one fraction rather than another, so that the dosage of nicotinic acid in a vasoconstrictor case or of riboflavin in a vasodilator case would be quite disproportionate to that of the other fractions.

THERAPEUTIC RESPONSE

The same 73 cases are available for reporting the results of treatment as were reported on in part I with regard to vertigo. These 73 cases comprise 101 affected ears, 21 in the vasoconstrictor group, 55

histamine groups, while mixed deafness of predominantly perceptive type occurred in smaller and more varied proportions but still in all groups and to a considerable degree. This series of cases thus conforms to the accepted pattern.

Nevertheless, deafness of conductive type played a not inconsiderable part in the hearing loss, a much greater part than is generally realized. Pure conductive deafness was found in 4 per cent of all ears only, but mixed deafness of predominantly conductive type occurred in 16 per cent. Moreover, a minor degree of conductive deafness was present in a further 27 per cent. Thus, while pure conductive deafness appeared in only a very small proportion of the ears involved, conductive deafness mixed with perceptive deafness in greater or lesser degree appeared in considerable proportion. But, and this is an interesting point, its incidence was almost exclusively in the intermediate and vasodilator histamine groups, the groups in which a deficiency of riboflavin is considerable or predominant. In the vasoconstrictor group, the group of predominantly niacin deficiency, conductive deafness in pure form did not appear at all and was predominant in only 2 of 12 ears with mixed deafness in this group.

These observations suggest that the factor responsible for the lesion causing a perceptive type of deafness in cases of Ménière's syndrome is a deficiency of niacin, while that responsible for the lesion causing a conductive type is a deficiency of riboflavin.

Furthermore, type of deafness can be correlated with type of vertigo. In part I of this communication¹ it was shown that positional vertigo was associated with riboflavin deficiency, while rotational vertigo was associated with niacin deficiency. Here it is seen that conductive deafness is associated with riboflavin deficiency, perceptive deafness with niacin deficiency. While it does not follow syllogistically that all patients with positional vertigo suffer from conductive deafness and that all patients with rotational vertigo suffer from perceptive deafness, nevertheless it is found that those patients in whom conductive deafness predominates complain predominantly or solely of positional vertigo, while those in whom perceptive deafness predominates, i. e., the large majority, complain predominantly or solely of rotational vertigo. Put in another way, rotational vertigo and perceptive deafness and tinnitus occur together, comprise the more commonly occurring triad and are associated with, and are apparently the result of, niacin deficiency, while positional vertigo when accompanied by cochlear disturbance is associated with conductive deafness and tinnitus and with riboflavin deficiency. But positional vertigo may, and often does, occur without accompanying cochlear disturbance (pseudo Ménière's disease), and it also is associated with riboflavin deficiency, as will

be seen elsewhere³ Hence it would seem that niacin deficiency when it affects the ear involves both cochlear and vestibular functions, that is to say, produces its effect at the periphery, probably through the autonomic nervous system Riboflavin deficiency, on the other hand, often affects the vestibular tract without the cochlear, and it is therefore possible that in some, at least, of such cases the site of the disturbance is central The available evidence suggests rather strongly that riboflavin deficiency can produce a disturbance either at the periphery or in the central tract and may even involve both coincidentally (see discussion under "Tinnitus," page 583 and footnote 3)

These observations and speculations are lent some support by the findings of Kuilman⁴ and De Raadt,⁵ two Dutch observers who worked independently of each other in prisoner of war camps in Batavia Kuilman observed 412 cases of what he calls "camp vertigo," vertigo of variable duration occurring at intervals from weekly to many times a day in which sudden head movement would often result in severe attacks of vertigo with nystagmus and nausea or vomiting Thirty-seven of these patients (9 per cent) were also "camp deaf," the deafness being especially for low tones Many of them suffered from frank pellagra, beriberi and other symptoms of nutritional deficiency which confirmed the impression of a nutritional disease He found no evidence of vestibular damage and he believed the symptoms to be due to a central disorder Nicotinamide, which was the only individual fraction of the B complex available to him, caused some improvement, but yeast treatment was found more effective

De Raadt reported on 160 cases of pellagra in which almost identical manifestations were observed, though in 26 per cent of his cases tinnitus and deafness were present Here again the deafness was of conductive type He stated his opinion that "the underlying pathology is a degenerative brain stem encephalitis" and that riboflavin deficiency plays the most important part in causing the symptoms of disturbance of the central nervous system

Severity of Deafness—Table 2 shows that when an element of conductive deafness was present the severity of the hearing loss increased The most severe loss was found in the 5 ears with pure conductive deafness, all of which had a loss of more than 40 decibels The least severe loss was in ears with pure perceptive deafness, 42 of the 62 (28 per cent) had a loss of less than 40 decibels In the

3 Atkinson, M Positional Vertigo Observations on Its Causes and Control, to be published

4 Kuilman, J Camp Vertigo, Nederl tijdschr v geneesk 90 983 (Aug 17) 1946

5 De Raadt, O L E Pellagra in Oto-Neurology and Rhino-Laryngology, Leiden, Universitaire Pers, Leiden, The Hague, Martinus Nijhoff, 1947

cases of mixed deafness the losses were intermediate in severity, but still of high degree, only 7 of the 52 ears (13 per cent) having a loss of less than 40 decibels. It seems, therefore, as though the factor responsible for the lesion producing a conductive type of deafness produces a more severe disturbance than that responsible for the perceptive type. If, as has been suggested, these factors are respectively a deficiency of riboflavin and a deficiency of niacin, then riboflavin deficiency appears to be the villain of the piece. When both deficiencies are present in more or less equal degree, as in the intermediate histamine group, the resulting disturbance is also severe, as would be expected—45 of the 52 ears (87 per cent) showing a loss of more than 40 decibels and 18 of these a loss of more than 60 decibels.

Bilateral Impairment—Cases of bilateral impairment, which point to either a more severe disturbance or a higher susceptibility, have been of much greater frequency in the intermediate histamine and vasodilator groups, in which riboflavin deficiency is a major or predominant factor, than in the vasoconstrictor group. Whereas in the vasoconstrictor group only 4 of 20 cases (20 per cent) were bilateral, in the intermediate histamine group 22 of 42 cases (52 per cent) and in the vasodilator group 11 of 24 (64 per cent) had significant impairment of hearing on both sides.

"Dead" Ears—There were 4 such ears, in which "death" had occurred after the onset of vertigo (resulting presumably from the disturbance under consideration, not from some previous infection). They indicate a disturbance of great intensity. They also were confined to the same two groups, the intermediate and the vasodilator (table 2).

The evidence is thus considerable for indicting riboflavin deficiency as responsible for a more severe disturbance than that due to niacin deficiency.

Absence of Bone Conduction—Absence of hearing by bone conduction with retention of hearing by air conduction has been described before as occurring in some cases of Ménière's syndrome.⁶ It has been observed in this series of cases only in the presence of pure or predominant niacin deficiency. So peculiar is such a phenomenon that doubt has, perhaps naturally, been cast on the validity of the observation,⁷ and until now, so far as is known, no adequate explanation has been offered for it. Dr E. P. Fowler Sr, however, in a personal communication, has provided one. He writes:

The maximum loudness of a tuning fork by bone conduction is usually between 50 and 60 decibels, but the loudness level of a noise box is much greater. Impedance

⁶ Mygind, S. H., and Dederding, D. *Les syndrômes méniériques*, Paris, Presses Universitaires de France, 1934.

⁷ Tumarkin, A. Letter to the Editor, *J. Laryng & Otol* **61** 297 (May) 1946.

through the skull being small, only 4 to 5 decibels, the margin between fork by air and bone conduction may be narrow, as also that between fork and noisebox by bone conduction. If, therefore, the degree of conduction deafness is 60 decibels or more, the masking noise may, by crossed bone conduction, mask out hearing by bone conduction while some small degree of hearing by air conduction for the same tuning fork is retained. In other words, if the contralateral masking sound is effective, it will be sensed also in the homolateral ear and therefore mask both ears.

Results of Treatment—Improvement in the degree of deafness of whatever type and in whichever group has been the exception. This accords with the general experience. In all, only 24 ears have shown any degree of improvement, though 5 of these gained 20 decibels or more, and in another 3 hearing returned to a normal level. No ears with pure conductive deafness showed any improvement, but 13 ears (24 per cent) with pure perceptive deafness improved, 1 returning to normal (table 3). It has already been mentioned that the best results were obtained in the vasoconstrictor (niacin deficiency) group, the poorest in the vasodilator (riboflavin deficiency) group, which again points to the severity of the lesion produced by riboflavin deficiency. However, though improvement is the exception, it is usually possible to prevent further deterioration of hearing and to overcome the distortion of hearing of which some patients complain. When, as not infrequently is the case, the patient experiences considerable spontaneous variation in hearing level, adequate treatment can restore hearing to the highest level attained spontaneously and maintain it there. This in itself is often a considerable achievement, for the highest level may approach the normal. It has been classified, however, not as improvement but as maintenance.

Although any marked improvement of hearing is exceptional, when it occurs the result may be startling. The audiograms shown in figure 2 are examples, one from each histamine group, of what can from time to time be achieved by exhibiting the suitable vitamin fraction in high dosage. The objective results obtained in this series with this method of treatment show a slight though definite improvement over those previously published by me,⁸ and the subjective improvement is often considerably greater. It must, however, be repeatedly insisted that such results, or any results in cases of Ménière's syndrome, have been achieved only by patient and persistent administration over long periods of the appropriate fraction or fractions in what by conventional standards must be regarded as extremely high dosage—nicotinic acid, 400 to 600 mg, nicotinamide, 1.5 to 2.0 Gm, riboflavin, 160 to 240 mg, thiamine, 200 to 400 mg daily.

8 Atkinson, M. Ménière's Syndrome. Results of Treatment with Nicotinic Acid in the Vasoconstrictor Group, *Arch Otolaryng* 40:101 (Aug) 1944.

Reasons for Failure—The question immediately arises why, when the hearing of a minority of patients can be so dramatically improved, the majority can expect only prevention of further deterioration, some

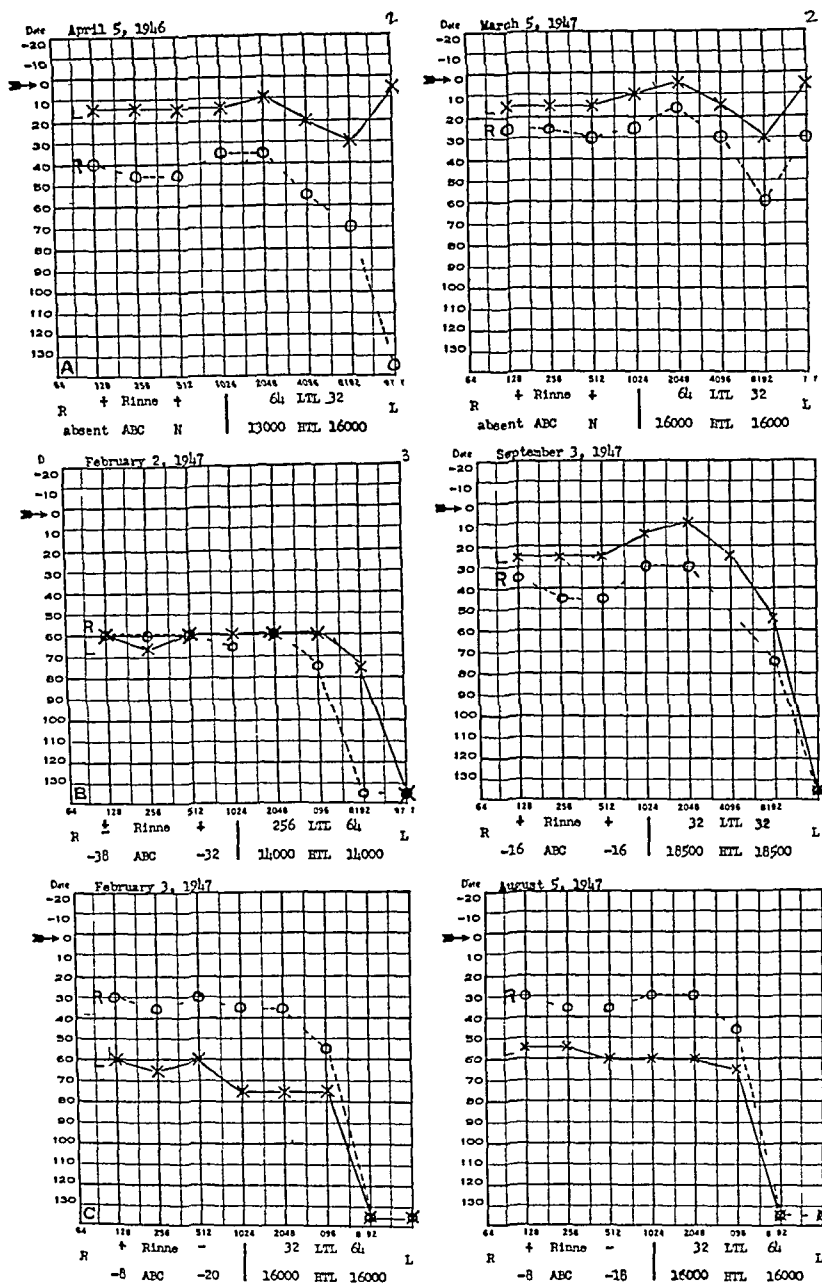


Fig 2—A, audiograms of a woman aged 23 years belonging to the vasoconstrictor group. She had perceptive deafness in the right ear. The hearing of this ear improved when she was treated with nicotinic acid. LTL signifies low tone loss, HTL, high tone loss, ABC, absolute bone conduction. B, audiograms of a man aged 35 years belonging to the intermediate group. He had severe mixed deafness in both ears. His hearing was greatly improved on administration of both nicotinamide and riboflavin. C, audiograms of a woman aged 61 years, belonging to the vasodilator group. She had mixed deafness, preponderantly conductive, in the left ear and mild perceptive deafness in the right ear. The hearing revealed little improvement after treatment with riboflavin.

not even that. One possibility lies in insufficient dosage, despite the high doses used, a possibility to which support is lent by the marked deterioration of hearing which has taken place in a few patients who stopped taking their oral dose when the attacks of vertigo ceased, and the equally marked improvement which has occurred with very massive dosage in a few of the patients on whom such dosage has been tried. This matter is at present under investigation, but many months must elapse before any sort of conclusion can be reached—the reversal of tissue change is of necessity a slow process even if it can be accomplished.

With this advocacy of high dosage, however, must go a warning. As with drugs, so with vitamins, there is a limit to individual tolerance, which in the case of vitamins varies as a general rule inversely with the age of the patient and the duration, *i. e.*, the chronicity, of the deficiency. The older the patient and the more long-standing and severe the deficiency, the less can he tolerate heavy dosage. It often makes such patients very uncomfortable, presumably by forcing a rusty metabolic mechanism to undue activity. However, they usually respond satisfactorily in terms of general well-being to small doses, and by such means degenerative changes can often be slowed down or even contained.

Here, then, is another reason for failure, irreversible tissue change. This is by no means always confined to elderly patients with degenerative lesions. Many younger patients have been encountered who have become severely deafened suddenly or within a day or so of the onset of vertigo and whose hearing has shown no change thereafter, despite energetic treatment. Presumably irretrievable damage has taken place. This likelihood is supported by the autopsy observations of Hallpike,⁹ who has reported cochlear degeneration in 3 of 5 cases. What occurs to produce this damage is at present not known.

A third possibility is the presence of some complicating factor which has been overlooked, such as an undiscovered source of infection, concurrent disease or some emotional disturbance—the last far from uncommon. Consideration of the role played by such factors must be left for a subsequent communication.

Finally, there may be some additional and as yet unrecognized, even unknown, factor to account for some cases of failure.

⁹ Dix, M. R., Hallpike, C. S., and Hood, J. D. Observations upon the Loudness Recruitment Phenomenon, with Especial Reference to the Differential Diagnosis of Disorders of the Internal Ear and VIII Nerve, *Proc Roy Soc Med* **41** 516 (Aug.) 1948.

TINNITUS

MATERIAL AND PROCEDURE

The material was the same 87 cases with which this investigation has been concerned throughout. The number of ears involved with tinnitus, however, was only 98, compared with 123 deaf ears. Thus 25 of the 36 patients who had bilateral hearing involvement (table 1) complained of tinnitus in one ear only.

The procedure was the same as that described in the previous section.

METHOD OF EXAMINATION

Each patient was carefully interrogated as to the sound or sounds which he heard and was asked to give as accurate a description as he could of each variety, and to indicate its severity.

An attempt was made at the beginning of this investigation to check pitch and intensity by balancing each on the audiometer. It was found impossible in most cases to do either effectively, and even when it could be done, results varied so much from one examination to another, while subjectively conditions remained much the same, that they seemed confusing rather than informative. This method of investigation was consequently abandoned, and reliance was placed solely on what each patient stated as to pitch and intensity of tinnitus and results of treatment, as well as on his description of the type of noise. It might be expected that such a subjective approach would be highly unsatisfactory, and certainly a more objective one would have been preferred. However, as it turned out, the similarity of descriptions of different varieties of tinnitus has been remarkable and the acuteness with which variations of pitch and changes of intensity were observed, sometimes by the most unexpected patients, has been a matter of surprise. As to results, the reaction of the patient in so subjective a condition is, from the clinical standpoint, perhaps as valuable as an audiometer reading of intensity.

RESULTS OF EXAMINATIONS

Typing of Tinnitus—Very early in this investigation it began to appear that two basic types of tinnitus could be distinguished. The outstanding characteristic of one, and the more frequently encountered, was the steady continuity of the sound, that of the other was a rhythmic or surging quality, though not pulsatile or synchronous with the heart beat.

The sounds heard in the two groups have been described by patients as follows:

1. Steady sounds. (a) "Buzz," "hum," "escaping steam." These three frequent descriptions, the last perhaps the most usual, seem to apply to a constant tinnitus, usually of low intensity, the difference conveyed by the different descriptions being of pitch rather than of quality.

(b) "Whistle." From time to time the low-pitched sounds of (a) may rise in pitch to a high whistle, commonly likened to that on a peanut vendor's stand. This change of pitch, if persistent, often denotes a period of exacerbation and may be the prelude to an attack of vertigo. Eventually the whistle may gradually replace the steam sound largely or entirely, an indication of increasing severity of the dis-

turbance, which is further shown by an accompanying diminution of hearing

(c) A "ringing or bell-like" sound This also is a steady sound, intermediate in pitch and intensity between a buzz and a whistle Because the sound when present is steady and continuous, it has been included in this group Whether or not it is due to the same disturbance as those in (a) and (b) and has the same site of origin is at present undetermined In no case in this series—indeed, in no case that I can recall—has a buzz been said to change to a ringing sound, though the change from a buzz to a whistle has often been described Further, though "ringing in the ears" is an everyday expression (hence the term "tinnitus"), yet patients when pressed for a description of the sound do not often use the term It may therefore be that the sound of ringing as distinct from buzzing or whistling indicates a different lesion or a different site

2 Rhythmic sounds Two descriptions are commonly used for this group of sounds "like a waterfall" and "like the roar of the ocean" In both these varieties the sound is of low pitch The descriptions seem to be applied to sounds of the same kind but of different intensity A third description sometimes applied to the rhythmic type of tinnitus is "the hum of machinery," but here some care in interrogation is necessary, for some patients mean by this description a rhythmic sound, others a constant sound

It must be repeated, lest misunderstanding arise, that the rhythmic type of tinnitus referred to here is not pulsatile or synchronous with the heart beat, nor is it associated with hypertension Strictly speaking, "pulsatile tinnitus" is not tinnitus at all, it is merely the perception of an extrinsic sound, the pulse The term "tinnitus" would be better restricted to the intrinsic type resulting from some disturbance in the auditory tract

3 Multiple sounds While many patients experienced one sound or one type of sound only, many others suffered at different times, or even at the same time, from both the steady and the rhythmic types Here, then, was a third group with mixed tinnitus

Types of Tinnitus Correlated with Type of Deafness—These observations suggested the possibility that the three types of tinnitus—steady, rhythmic and mixed—could be correlated with the three types of deafness—perceptive, conductive and mixed Such a correlation can in fact be made

Consideration of table 4 shows that of the 42 ears with deafness of pure perceptive type, 37 (88 per cent) had steady tinnitus only, none had rhythmic tinnitus only, and 5 (12 per cent) had tinnitus of both types On the other hand, of the very small group of 5 ears with

pure conductive deafness, none had steady tinnitus only, but 3 (60 per cent) had rhythmic tinnitus only, and 2 (40 per cent) had tinnitus of both types. This suggests that the steady type of tinnitus is an expression of the lesion causing a perceptive type of deafness, while the rhythmic type is an expression of the lesion causing a conductive type of deafness. The findings in the mixed deafness group are consistent with this suggestion. Steady tinnitus alone was present in 25 cases (48 per cent), rhythmic tinnitus alone in 5 cases (10 per cent) and mixed tinnitus in 21 cases (42 per cent). Reference to table 1 will show that these proportions are almost exactly those of the incidence of the different types of hearing loss.

As a result of these findings, it has seemed reasonable to designate the steady type of tinnitus as perceptive tinnitus, the rhythmic type as conductive tinnitus, and tinnitus in which both sounds are heard as mixed tinnitus, in conformity with the nomenclature of deafness.

TABLE 4—*Tinnitus Types Associated with Different Types of Deafness*

Types	Constant	Mixed	Rhythmic	Total	
Perceptive deafness (42 ears)	37 (88%)	5 (12%)	0	42	Cacophonous 1
Mixed deafness (51 ears)	25 (48%)	21 (42%)	5 (10%)	51	Cacophonous 5
Conductive deafness (5 ears)	0	2 (40%)	3 (60%)	5	
Total	62 (63%)	28 (30%)	8 (7%)	98	

Unclassified Sounds—Three other sounds, which cannot as yet be classified with any certainty, have been complained of from time to time.

1 *Cacophonous tinnitus* This form of tinnitus luckily has not been common. It is a jangling medley of discordant sounds, "an orchestra playing out of tune", it is most distressing but fortunately is usually short lived. "Indeed," said one sufferer, "I do not think it could be endured for long." It has occurred only in the most severely afflicted patients, has always been associated with other types and is probably a severe form of mixed tinnitus. There have been 6 instances in this series, 5 in patients with mixed deafness and 1 of relatively mild degree in a patient with apparently pure perceptive deafness. All the patients were having frequent severe attacks of vertigo, and in all the cacophonous tinnitus disappeared rapidly under treatment, together with the attacks of vertigo.

2 *"Explosions"* Sudden loud bangs in the ear have been complained of by members both of the vasoconstrictor and of the intermediate histamine groups. They have not been encountered in any member of the vasodilator group. Their origin is undetermined, but the likelihood seems to be that of some sudden vascular effect such as

a temporary release of vasospasm. They have occurred only in the more severe forms of the syndrome or during periods of exacerbation, and, like cacophonous tinnitus, are not an isolated phenomenon. They have ceased quickly once adequate treatment has been instituted.

3 Clicking sounds. Repeated clicking in the ear, often regular and long sustained, has occurred infrequently in all groups. The origin of this sound is not certain, but it is usually believed, probably correctly, to be an extrinsic sound originating in the muscles of the pharynx.

Grouping of Cases of Tinnitus According to the Results of the Histamine Skin Test—In table 5 the numbers of cases of the three types

TABLE 5—*Tinnitus Types According to Histamine Groups*

Group	Perceptive Tinnitus				Mixed Tinnitus				Conductive Tinnitus				Total (Ears)
	+	2+	3+	4+	+	2+	3+	4+	+	2+	3+	4+	
Vasoconstrictor Histamine — 20 cases, 24 ears Niacin deficiency	1	6	12	0	0	0	4	0	0	0	1	0	24
	19 (80%)				4 (16%)				1 (4%)				
Intermediate Histamine ± 42 cases, 47 ears Mixed deficiency	4	5	19	1	0	4	6	6	0	0	2	0	47
	29 (62%)				16 (34%)				2 (4%)				
Vasodilator Histamine + 24 cases, 27 ears Riboflavin deficiency	2	4	7	1	0	1	2	5	3	0	2	0	27
	14 (52%)				8 (30%)				5 (18%)				
Total (ears)	7	15	38	2	0	5	12	11	3	0	5	0	98
	62 (63%)				28 (30%)				8 (7%)				

+ = soft, 2+ = medium, 3+ = loud, 4+ = distressing

Bilateral Cases

Vasoconstrictor group	4 (20%)
Intermediate group	5 (12%)
Vasodilator group	3 (12%)

of tinnitus which have occurred in each of the three histamine groups is shown, and the degree of severity indicated by the patient has been designated as 1 plus to 4 plus as explained in the key. The "4 plus" cases are discussed more fully in a later paragraph.

It will be seen that by far the most common type to appear in pure form was the steady perceptive type. It occurred in 50 per cent or more of all ears in each group—in the vasoconstrictor group in as much as 80 per cent of 24 ears. The rhythmic, conductive type alone was not common, occurring in only 4 per cent of ears in the vasoconstrictor and intermediate groups, but in 18 per cent of 27 ears in the vasodilator group. When associated with perceptive tinnitus, as the

mixed type, however, conductive tinnitus was much more common, and its relative incidence is interesting. In the vasoconstrictor group conductive tinnitus, alone or associated, was present in only 16 per cent of ears, but in the vasodilator group it was present in 30 per cent of ears and in the intermediate group in 34 per cent. These figures follow closely those for hearing loss (see table 2), a finding which lends further support to the contention that each type of deafness has its own type of tinnitus.

To translate these findings into terms of vitamin deficiency, perceptive tinnitus, like perceptive deafness, is associated with niacin deficiency and conductive tinnitus, like conductive deafness, with riboflavin deficiency, while mixed tinnitus, like mixed deafness, is associated with a deficiency of both.

Distressing Tinnitus—Tinnitus of this severity is luckily not common, causing as it does great mental distress, interfering with sleep and adding greatly to the sufferings of the patient. Thirteen patients have presented examples of it in this series: the 6 patients with cacophonous tinnitus already mentioned, 5 patients who described in varying terms a constant rhythmic roar which they found deeply disturbing and which was usually associated with other sounds and 2 patients who complained of a steady screaming sound, unadulterated by any other.

The distribution of these patients according to histamine grouping is interesting (table 5). There were no such patients in the vasoconstrictor group, 6 were in the vasodilator group and 7 in the intermediate histamine group. Thus all fall into one of the groups in which riboflavin deficiency is a major factor. Here is further confirmation of the observation noted in the previous section on deafness, that riboflavin deficiency produces a more severe type of disturbance than niacin deficiency.

Bilateral Tinnitus—Bilateral tinnitus has been considerably less frequent than bilateral impairment of hearing—12 cases, compared with 37. It was present in all 4 cases of bilateral impairment of hearing in the vasoconstrictor group, but in only 5 of the 22 in the intermediate group and 3 of the 11 in the vasodilator group. It would seem, therefore, that niacin deficiency is more liable to produce tinnitus than riboflavin deficiency even though riboflavin deficiency appears to produce the more severe disturbance. This is not so paradoxical as it may sound (see "Comment").

"Dead" Ears—In the previous section 3 ears were reported "dead" to audiometric and vestibular test yet appeared to be the operative ears, the ear on the other side being normal to test. In each case tinnitus was present. In a fourth ear, "dead" as a result of total section of the eighth nerve, tinnitus was also present. Moreover, in 3 other

cases in which the ears were "dead," reputedly as the result of an acute specific fever in childhood, tinnitus of the "dead" ear was complained of and was stated to have been present "always" This suggests either that present tests of function are not delicate enough and that these apparently "dead" ears were not in fact functionless, or that the sensory disturbance which is known as tinnitus can be displaced centrally to a higher level, so that the stimulation of the sensorium continues even though the end organ has ceased to function (see "Comment")

THERAPEUTIC METHOD AND RESPONSE

Again the same 73 cases are available for reporting results of treatment as in the previous section, but the number of ears affected with tinnitus was only 81, compared with 101 ears showing impairment of hearing (table 3) The method of treatment was that described in the previous section

TABLE 6—*Tinnitus Results of Treatment*

Group	Relieved				Improved				No Change				Worse				Total (Ears)
	P	M	O	Total	P	M	O	Total	P	M	O	Total	P	M	O	Total	
Vasoconstrictor Histamine — 17 cases, 21 ears	3	1	0	4	11	1	1	13	3	1	0	4	0	0	0	0	21
	4	—19%			13	—62%			4	—19%			0				
Intermediate Histamine ± 38 cases, 42 ears	5	1	0	6	9	5	4	18	9	4	1	14	3	1	0	4	42
	6	—14%			18	—42%			14	—35%			4	—9%			
Vasodilator Histamine + 18 cases, 18 ears	2	0	0	2	8	2	1	11	2	3	0	5	0	0	0	0	18
	2	—11%			11	—61%			5	—28%			0				
Total (ears)	10	2	0		28	8	6		14	8	1		3	1	0		81
	12	—15%			42	—51%			23	—29%			4	—5%			

The results of treatment have been considerably better with regard to tinnitus than with regard to deafness, as will be seen by comparing tables 3 and 6 Whereas only 3 per cent of patients with hearing loss in all three groups have been relieved (returned to normal), 15 per cent have been completely relieved of tinnitus, whereas 21 per cent of patients have been improved as regards deafness, 51 per cent have been improved as regards tinnitus, and whereas 15 per cent of patients have deteriorated as regards hearing, only 4 per cent have deteriorated as regards tinnitus Thus tinnitus has been more easy to control than impairment of hearing, and this applies to all groups and all types It is worthy of note that the only group in which worsening of tinnitus occurred in spite of treatment was the intermediate group, in which mixed deficiencies of severe degree were the rule Indeed, the results in general in that group were worse than in either of the other two The most satisfactory results have been obtained in the vasoconstrictor (niacin-deficient) group This conforms to the findings for vertigo and hearing loss

It must be emphasized again here that constant, unremitting treatment, often extending over many months, may be necessary to obtain the results described. Control of tinnitus, like improvement of hearing, is uncertain and in any event seldom comes about rapidly, since it involves repair of damaged nerve tissue, notoriously a slow process. Physicians must realize this and patients be made aware of it if disappointment and disillusionment are to be avoided.

COMMENT

Site of Origin—As has been pointed out elsewhere,¹⁰ the auditory tract is phylogenetically a peripheral sensory tract modified to subserve the function of a special sense. Intrinsic tinnitus represents a disturbance of function of that sensory tract and may thus be regarded as auditory paresthesia, while deafness, which represents a more severe degree of that disturbance, to the point of partial or complete abolition of function, may be regarded as auditory hypesthesia or anesthesia. In other words, if this concept is valid, the symptoms known as deafness and tinnitus are evidence of a disturbance of function of a sensory mechanism, and the problem of their causation should be considered from this point of view.

This approach, however, introduces certain difficulties, having regard to current otologic concepts. The first difficulty concerns nomenclature and site of origin. Conductive, or middle ear, deafness denotes to the otologist a lesion which interferes with the "conduction" of sound waves to the inner ear and which may be situated anywhere between the external auditory canal and the articulation of the stapes in the oval window, in what may be called the external auditory apparatus. Now this external auditory apparatus, comprising the pinna, the external auditory canal, the tympanic membrane and the ossicles, is in actual fact no more than a mechanism, however complicated in structure and action, for collecting and modifying sound waves in order to transmit them at suitable intensity to the receptor end organ of Corti. Such a receptor has been called by Sherrington a distance receptor. From the physiologic point of view, therefore, the external and middle ear should be included with the cochlea as part of a receptor mechanism. If this orientation is correct, a lesion of the end organ should give rise to the same signs as those which are characteristic of a lesion of the external auditory apparatus. In other words, in the absence of evidence of a lesion of the external auditory apparatus, signs of conductive deafness implicate the organ of Corti (fig. 3).

This concept runs counter to present day otologic teaching, but it would seem that only if it is true can the fact of tinnitus associated

¹⁰ Atkinson, M. Tinnitus Aurium. Observations on Its Nature and Control, *Ann Otol, Rhin & Laryng* 53 742 (Dec.) 1944

with a lesion of the middle ear and its accompanying conductive deafness be adequately explained. For, if it is agreed that tinnitus is auditory paresthesia, then tinnitus can arise only from disturbance in auditory nerve tissue, and no part of the auditory tract enters the middle ear. But if the end organ is included with the middle ear as part of that apparatus a lesion of which causes the condition known as conductive deafness, then tinnitus associated with such deafness at once becomes

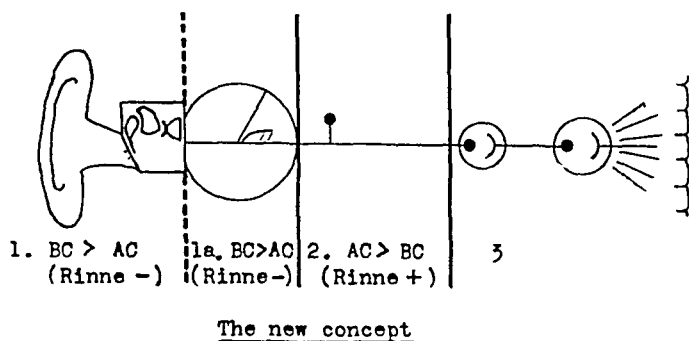
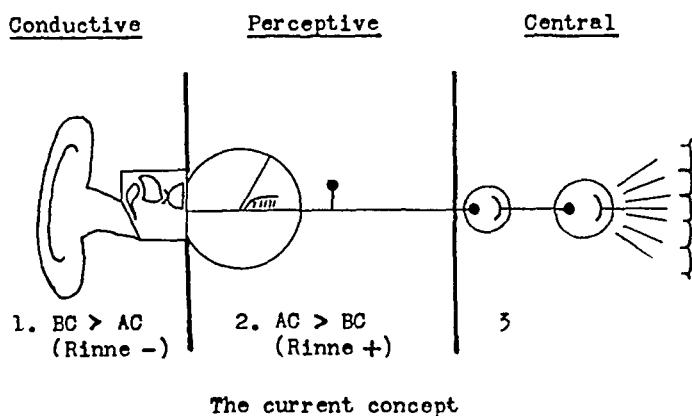


Fig 3—Diagrams illustrating the current concept and a new concept of the sites of lesions causing different types of deafness. *AC* stands for air conduction, *BC*, for bone conduction.

1 Middle ear deafness. *BC* is better than *AC* because the lesion interferes with the transmission of sound waves.

1a Cochlear deafness. *BC* is better than *AC* because the damaged cochlea responds more effectively to the powerful mechanical stimulus employed to transmit sound waves through bone than to the less powerful normal stimulus of air transmission.

2 Nerve deafness. *AC* is better than *BC*, the normal relationship, but both are reduced because a lesion of the nerve interferes with conduction of normal impulses produced by an undamaged cochlea.

3 Central deafness. A rarity not under consideration.

intelligible as arising from a cochlear disturbance. Moreover, if the preceding argument is acceptable, a reasonable explanation is at once

available for the observations reported in this paper, that tinnitus associated with conductive deafness is of a type different from that associated with perceptive deafness. The one arises in the end organ, a highly differentiated nervous structure, the other in the auditory nerve, a relatively undifferentiated nervous structure, and it might be expected that the two would be different. Further, the observation that the two types of tinnitus seem to result from different vitamin deficiencies becomes also explicable, since it is well known that deficiency of specific fractions of the B complex affects specific organs. This fact in its present reference will be discussed more fully later.

Turning now to perceptive, or nerve, deafness, this denotes to the otologist a lesion of the inner ear and/or the auditory nerve. The physiologic process, however, is that sound waves received by the the organ of Corti are converted there into electrical impulses, and these impulses are conducted along the nerve fibers to the central tracts and so to the perceptive sensorium. The type of deafness which arises from a lesion of the nerve, therefore, though called perceptive, is actually the result of an interference with conduction of nerve impulses. Moreover, inner ear deafness and nerve deafness are not to be regarded as synonymous, if this concept is valid, since physiologically the end organ belongs to the external auditory apparatus.

It has seemed necessary to discuss at some length this question of the sites of origin of the two different types of deafness, and in particular the physiologic innovation of orienting the end organ with the external auditory apparatus rather than with the auditory nerve, because only in some such way can an explanation be offered for the observations recorded in this paper. These observations show that a distinctive type of tinnitus is associated with each type of deafness, and since the two types of deafness result from lesions at different sites, the corresponding types of tinnitus presumably arise at the same sites. But if true intrinsic tinnitus can arise only in nerve tissue, then, while the explanation of intrinsic tinnitus associated with a lesion of the peripheral nerve is simple, the explanation of intrinsic tinnitus associated with deafness of middle ear, or conductive, type is impossible unless the end organ is accepted as part of the external auditory apparatus. If it is so accepted, then the rest is simple. Deafness of so-called conductive type not the result of a lesion of the middle ear or the ossicles must be due to a lesion of the end organ, is cochlear deafness, and the accompanying tinnitus arises there. Deafness of so-called perceptive type is due to a lesion of the auditory nerve trunk, and the accompanying tinnitus arises in the nerve fibrils composing it.¹¹

By orienting the cochlea with the external auditory apparatus and away from the nerve trunk one is able to account for a finding which

¹¹ Fowler, E. P. Tinnitus Aurium in the Light of Recent Research, *Ann Otol, Rhin & Laryng* 50 139 (March) 1941

was demonstrated but not discussed in the section on deafness and which is otherwise difficult to explain—that hearing loss of “nerve” type is associated predominantly with deficiency of one factor (niacin), while hearing loss of “middle ear” type is associated predominantly with deficiency of another factor (riboflavin). What is known of the clinical effects of niacin deficiency indicates that niacin is essential to the normal functioning of the autonomic nervous system, as thiamine is to the normal functioning of the voluntary nervous system. Among other things, therefore, it is concerned with the caliber of the blood vessels, a deficiency resulting in vasoconstriction. Such vasoconstriction, if it occurs in the auditory artery, will interfere with the nutrition of the nerve trunk and result in hearing loss of nerve, or “perceptive,” type. The organ of Corti, being an avascular structure, will not be affected, at least not directly.

Riboflavin, on the other hand, seems to be concerned among other things with the nutrition of avascular structures, the oxidation-reduction process of its enzyme system apparently taking the place of hemoglobin in such structures. An avascular structure in which the effects of riboflavin deficiency can actually be seen is the cornea, invasion of which by new capillaries can be observed with the slit lamp,¹² while circumcorneal injection can be seen with the naked eye. These vascular changes represent an effort on the part of the body to compensate for the deficiency of riboflavin by an increase in blood supply. The organ of Corti similarly is an avascular structure, and it does not seem unreasonable to conjecture that a similar process may occur there in subjects of ariboflavinosis. And, just as in the eye dimness of vision results from corneal infiltration, so in the organ of Corti dimness of hearing may be expected to result from a similar process.

In the fact that these two deficiencies involve different structures and the fact that both deficiencies are frequently present together in considerable degree lies also an explanation of the mixed deafness and tinnitus which occur in so many cases of Ménière's syndrome. When both end organ and auditory nerve are damaged by a deficiency of riboflavin and niacin, respectively, signs of hearing loss of both types are found and tinnitus of any variety can be expected and explained.

Types of Tinnitus—If the argument advanced is accepted, it would scarcely be cause for surprise if a lesion of so highly specialized an end organ as the cochlea produced a distorted sensory response different from, and even more severe than, that produced by a lesion of the less differentiated nerve trunk. This is what the observations recorded in the foregoing pages suggest, and the results of treatment support the suggestion. The steady type of tinnitus responds to niacin but not to riboflavin, while the rhythmic type responds to riboflavin but not to

12 Kruse, H. D., Sydenstricker, V. P., Sebrell, W. H., and Cleckley, H. M. Ocular Manifestations of Ariboflavinosis, *Pub. Health Rep.* 55:157 (Jan. 26) 1940.

niacin Indeed, if nicotinic acid with its vasodilator action be given to patients with a rhythmic type of tinnitus it may increase their distress, just as nicotinic acid given to the vasodilator group will increase the frequency and severity of the attacks of vertigo

However, if this thesis that tinnitus is a paresthesia arising in an end organ or a peripheral nerve is to be maintained, there are certain discrepancies which must be explained Why, for instance, is tinnitus still present at times in an ear whose auditory function has been destroyed, as in the "dead" ears in this series? Why does total section of the eighth nerve only occasionally produce relief of tinnitus? The only feasible explanation would seem to be that the site of the disturbance is now no longer in the end organ or in the nerve distal to the site of section, but has been displaced centrally This central displacement of the site of origin of a disturbance of the peripheral sensory apparatus is well known in the condition known as causalgia, in which displacement of disturbance from periphery to cord or even thalamic level is responsible for continuance of pain even after amputation, *i e*, painful phantom limb¹³ Intractable tinnitus has many of the features of causalgia, for instance, there is the extreme distress caused in some cases by what to the normal person would be an inconsiderable stimulus, while tinnitus which persists in a "dead" ear is closely analogous to the pain which is felt in a phantom limb

Effect of Treatment—Tinnitus has been more effectively controlled than impairment of hearing—which, on the basis of this concept, is understandable Paresthesia—in this case tinnitus—is the expression of an active, continuing process, hypesthesia or anesthesia—in this case hearing loss—is the result of that process The result may be reversible, dependent on such factors as the severity of the process and the duration of its action, the process itself should be capable of control, at least in its early stages, provided that its cause is understood Cessation of tinnitus indicates cessation of the active process, recurrence of tinnitus points to a recrudescence of the process and is an indication for more intensive treatment But cessation of the active process does not automatically involve restoration of function, so that tinnitus can more often be relieved than deafness

With regard to specific treatment, the results as regards both deafness and tinnitus have been considerably better in the niacin-deficient group than in the two groups in which riboflavin deficiency is a major factor This conforms with the finding as regards deafness Perhaps riboflavin deficiency is more difficult to overcome than other deficiencies

13 Wilson, S A K Dysaesthesias and Their Neural Correlates, in *Modern Problems in Neurology*, New York, William Wood & Company, 1929 Livingston, W K Pain Mechanisms A Physiologic Interpretation of Causalgia and Its Related States, New York, The Macmillan Company, 1943 Henderson, W R, and Smyth, G E Phantom Limbs, *J Neurol, Neurosurg & Psychiat* **11** 88 (May) 1948

Certainly what is generally regarded as unusually high dosage of riboflavin (200 mg a day) often fails to produce material improvement, though in 1 or 2 cases a still further increase of dosage has seemed to help, so that even at that level dosage may be too low. On the other hand, riboflavin deficiency may produce a more severe lesion, and thus its results may be more liable to be irreversible. This seems more probable. The evidence points to riboflavin deficiency as causing damage to the highly differentiated organ of Corti, and the more highly differentiated the structure, the more susceptible it is to alteration of internal atmosphere. It may be that to this fact is due the difficulty of reversing the disturbance of function which occurs as a result of riboflavin deficiency, whether expressed as tinnitus or deafness.

SUMMARY

Perceptive deafness has been shown to be the most common variety of hearing loss in this as in other series, nevertheless, conductive deafness in some degree has been not unusual, occurring occasionally in pure form but more usually combined with perceptive deafness, a combination termed the mixed variety of deafness.

Bilateral hearing loss, more pronounced on one side than on the other, has occurred in almost half the cases (43 per cent). Bilateral tinnitus has been present much less frequently.

Absence of bone conduction with retention of air conduction has been observed in an appreciable number of cases.

Specific types of tinnitus have been found associated with the two varieties of hearing impairment, perceptive and conductive.

Specific vitamin deficiencies have been found associated with specific types of deafness and tinnitus, niacin deficiency with the perceptive type, riboflavin deficiency with the conductive.

The suggestion has been made on physiologic grounds that the cochlea should be included with the external auditory apparatus as part of the anatomic mechanism of conductive deafness, an orientation which can explain the specific auditory effects of specific vitamin deficiencies.

The results obtained as regards deafness and tinnitus when patients were treated with the appropriate vitamin fractions have been described and discussed.

Dr H. D. Kruse contributed advice and help in this investigation on the nutritional deficiency aspect and Dr Samuel Brock on the neurologic aspect.

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ACUTE DEAFNESS IN SCARLATINA

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NEWARK, N J

IT IS AN old experience that occasionally a child with scarlatina may become acutely deaf and eventually deaf-mute. The acute deafness in these instances is thought to be caused by purulent panotitis or, according to the observations of Wittmaack,¹ by neuritis of the cochlear nerve. Manasse² was the first to emphasize that acute deafness in scarlatina may be caused by diffuse purulent labyrinthitis on one side and serous labyrinthitis on the other. In the case of Manasse² there was necrotic otitis media on both sides, which had caused diffuse purulent labyrinthitis on the left, and on the right, localized purulent labyrinthitis in the round window, this, in turn, had caused diffuse serous labyrinthitis. This type of serous labyrinthitis has been called "secondary" by Ruttin³ because it originates from localized purulent labyrinthitis. It must be distinguished from "induced" diffuse serous labyrinthitis, in which there is no purulent focus in the labyrinth and in which the infection travels, rather, from the tympanic cavity through the intact windows into the inner ear.

The present case is reported to prove that acute deafness in scarlatina may be caused by common otitis media, that is, not acute necrotic otitis plus diffuse serous labyrinthitis on both sides.

REPORT OF A CASE⁴

A white girl aged 14 had a childhood history of pneumonia, measles, whooping cough, chickenpox and, at the age of 6, diphtheria. She frequently complained of trouble with the heart. On May 17, 1936, she had a slight common cold, but she was able to join her class on a trip to Salzburg on May 20. She returned to Vienna on May 24. On May 25 she complained of being fatigued, and on May 26

This article is dedicated to the memory of Hofrat Prof Dr E Urbantschitsch, of Vienna, in high esteem for his outstanding work in otolaryngology.

1 Wittmaack, K. Weitere Beiträge zur Kenntnis der degenerativen Neuritis und Atrophie des Hörnerven, *Ztschr f Ohrenh* **53** 1, 1906-1907.

2 Manasse, P. Zur Lehre von der plötzlichen Ertaubung bei Scharlachotitis und zur Kenntnis der serösen Otitis interna, *Arch f Ohrenh* **89** 146, 1912.

3 Ruttin, E. Die konservative und chirurgische Behandlung der Labyrinthentzündungen, *Ztschr f Hals-, Nasen- u Ohrenh* **18** 104, 1927.

4 Prof Dr Hofrat E Urbantschitsch performed the otologic examination and operation in this case and placed the temporal bones at my disposal for microscopic study.

she had fever On May 27 she had a scarlatinal exanthem, and on May 29, slight pain in both mastoid regions On May 31 a paracentesis was performed on both sides, releasing blood from the tympanic cavities On the evening of this day she suddenly became deaf and could hear only the raised voice On June 2 the temperature reached 104 F and she was delirious, there were signs of heart failure On June 3 the patient could not hear even the raised voice There was no discharge from either ear

On her admission to the hospital, on June 5, her sensorium was clear and the cranial nerves were normal Her pulse rate was 108 She had bronchitis on the left side, strawberry tongue, eczema of the vestibulum nasi and necrosis of the pharyngeal mucosa The lymph nodes at the angle of the mandible on the left side were swollen The tonsils had been removed previously The spleen was enlarged There was scaling of the fingers, toes and trunk No meningeal symptoms were discovered There were 28,500 leukocytes in the blood (67 per cent polymorphonuclear cells, 28 per cent lymphocytes and 5 per cent juvenile forms) and a large number of thrombocytes No albumin was present in the urine On June 8 the patient was delirious at times The right tympanic membrane was red and slightly bulged There was a perforation in the posterior and inferior quadrant the size of a pinpoint, releasing pus with pulsating motions There was tenderness over the right mastoid process but no edema On the left side, the conditions were the same, but in addition there were sagging of the superior and posterior wall of the external auditory canal, edema of the tip of the mastoid and more pronounced tenderness over the mastoid The patient was stone-deaf on the left side, on the right, she could hear only noises There was no spontaneous nystagmus, and the caloric test revealed hypoexcitability on both sides On account of her poor general condition, only an antrotomy was performed on both sides

On June 10, there was a slight discharge from the right ear and more from the left Thrush involved the mucosa of the lips and cheeks On June 11 the temperature was 103 F There was no dehydration, but the lymphadenitis on the left side had increased On June 12 the temperature was decreasing, and there was moderate trismus On June 13 the temperature rose again to 103 F The necrosis extended toward the lateral walls of the pharynx and to the recesses of the tonsils There were epistaxis and vomiting The leukocyte count was 12,050, with 70 per cent polymorphonuclear cells, 18 per cent lymphocytes, 4 per cent monocytes and 8 per cent juvenile forms On June 14 the temperature was 104 F On June 15 the infection of the right mastoid was almost cleared, but there was discharge from the left side The temperature was 101 F The child felt better, but Loeffler's bacillus was cultured from the nasal secretion, and there were membranes in the right nostril There were abducens paralysis on the left side and anesthesia of the skin of the left cheek and both corneas, more pronounced on the left side The fundi were normal

On June 16 the temperature was 100.8 F The pharyngeal mucosa was red, and the tongue was coated but moist On June 18 a small ulceration of the left cornea was noticed The temperature fluctuated about 98.6 F On June 22 there was a trace of pus in the right mastoid cell and a little more in the left There were pronounced rhinolalia and a swelling at the back of the right foot She complained of trouble in swallowing The paralysis of the abducens and trigemini nerves persisted On June 26 she had no fever but had a slight paresis on the left side of the face On July 1 there was a serous exanthem The temperature was 99 F, the leukocyte count was 12,150, with 60 per cent polymorphonuclear cells, 2 per cent juvenile forms, 2 per cent monocytes, 35 per cent lymphocytes, 1 per cent eosinophils and a large number of thrombocytes On

July 2 the Pirquet reaction was negative. On July 4, there was no fever, but albumin was present in the urine. On July 6, the infection of the right mastoid was cleared, but there was a moderate amount of pus on the left side and a poor formation of granulations. On July 7 there was paralysis of the soft palate. On July 13 there was a slight discharge from the left mastoid antrum. The patient was stone deaf on the left side and on the right side had a hearing for noises only.

On July 15 an abscess had formed on the left thigh. On July 16 the paresis of the soft palate was more pronounced and there was definite rhinolalia. On July 17 there was an increase of secretion from the left mastoid. The abscess of the thigh was incised. On the morning of July 17 the child felt well, but during the day the difficulty in swallowing increased. There was paralysis of the soft palate, of the pharynx and larynx and of the left abducens nerve. In the afternoon, bronchopneumonia developed, and the patient died on July 18. Autopsy revealed that scarlatina had occurred eight weeks and diphtheria five weeks before death. The lingual tonsil was enlarged, and there was a high degree of dilatation of the heart. In the myocardium were gray foci the size of pinpoints, indicating diphtheria of the myocardium. There were bronchopneumonia of the lower lobe of the right lung and a high degree of swelling of the tracheobronchial lymph nodes, also purulent bronchitis, enlargement of the spleen and hyperemia and edema of the brain.

Macroscopic Lesions of the Temporal Bones—In the right mastoid process there was a surgical cavity filled with granulations. There were large pneumatic cells in the squama temporalis and in the malar process. In the area of the saccus endolymphaticus the dura was split into two membranes, the inner membrane bulged, probably owing to an enlargement of the saccus endolymphaticus. The sigmoid sinus, the jugular bulb and the jugular vein were narrow, but the inferior petrosal sinus was enlarged. In the left mastoid there was a surgical cavity filled with pus. The antrum was large. The sigmoid sinus and the jugular bulb was very large, the latter extending up to the saccus endolymphaticus. The internal meatuses were normal on both sides and did not contain pus.

Microscopic Observations on the Temporal Bones—The sections through the vestibulum and the semicircular canals on the right side had been lost.

Left Temporal Bone The temporal bone was very well pneumatized, the cells extending to the apex of the pyramid. Some of the cells had a normal configuration, but the mucosa was extremely swollen and there was pus or serous exudate within the narrow cavity. Another part of the cells had been destroyed by the infection. The cells had been replaced by firm connective tissue which contained large cavities filled with frank pus. At the boundaries of this area were many Howship lacunas, but no osteoclasts. At other sites there was formation of new bone at the boundaries of the infected area. This area of destruction occupied the apex, extended into the floor and the roof of the internal meatus and encircled the canal of the internal meatus. Lateralward, toward the internal ear, the area became smaller and involved the periosteal layer of the bony capsule of the inner ear (fig 1). The endochondral layer remained almost normal. The area extended above the cochlea and, mesial to the endolymphatic duct, toward the epitympanum and the mastoid, where it was continued by pneumatic cells filled with pus and swollen mucosa (fig 2). This area did not reach the dura and did not extend into the internal ear, the internal meatus, the bulb of the jugular vein or the endolymphatic duct. But there were several small fistulas leading into the bony carotid canal (fig 1). However, these fistulas were filled with connective tissue. The jugular bulb and the soft tissue of the carotid canal were normal.

The internal ear was poorly preserved. In the internal meatus the nerves were normal and there was no pus. In the modiolus the capillaries were enlarged and there was periosteal edema in the nerve channels. The number of spiral nerves and cells of the spiral ganglion was apparently not diminished except in the lower portion of the basilar coil, where a moderate decrease in number of the ganglion cells was discovered. Within the cochlea there was no pus, but a small amount of serous exudate, which stained with eosin, filled both the perilymphatic and the endolymphatic space (figs 1, 2 and 3). Reissner's membrane

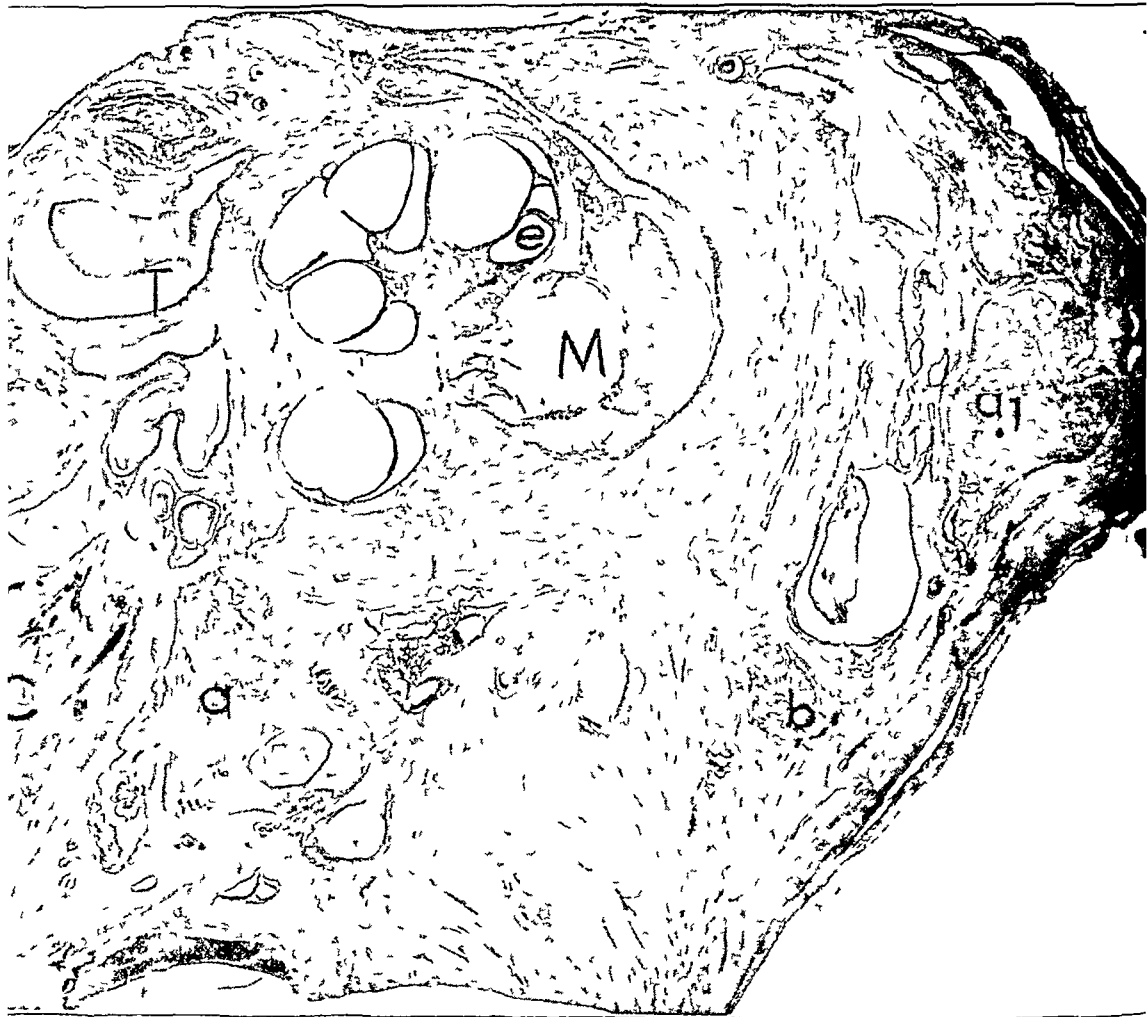


FIG 1—Section through the cochlea, tube (T), internal meatus (M) and carotid artery (C), on the right side. In this figure, *a* and *a*₁ indicate healing of osteitis of the petrous bone with formation of connective tissue (remnants of pneumatic cells in these areas), *b* shows a pneumatic cell of the petrous bone filled with newly formed bone, and *e*, serofibrinous exudate in the scala tympani of the basilar portion.

was extremely depressed, reducing the size of the lumen of the cochlear duct to a high degree, particularly in the superior portion of the basilar and the middle coil. In this area the cochlear duct formed a slit, filled with serous exudate. The crista spiralis, Corti's membrane and Corti's organ were compressed, but the

stria vascularis was normal. In the other coils, Corti's organ showed pronounced postmortem changes. There was serous exudate in the utricle and in the superior semicircular canal (fig 3). The macula and the cristae were apparently normal but showed postmortem changes. The cochlear aqueduct was patent.

The mucosa of the tube and the middle ear showed massive inflammatory edema (fig 3). Within the edematous mucosa were the ossicles, the boundaries of which showed numerous Howship lacunae. The epithelium of the mucosa was columnar and was absent only in the area in which operation had been performed. The recess of the oval window was entirely filled with the edematous mucosa. The stapes was dislocated toward the tympanic cavity (fig 3), its boundaries were

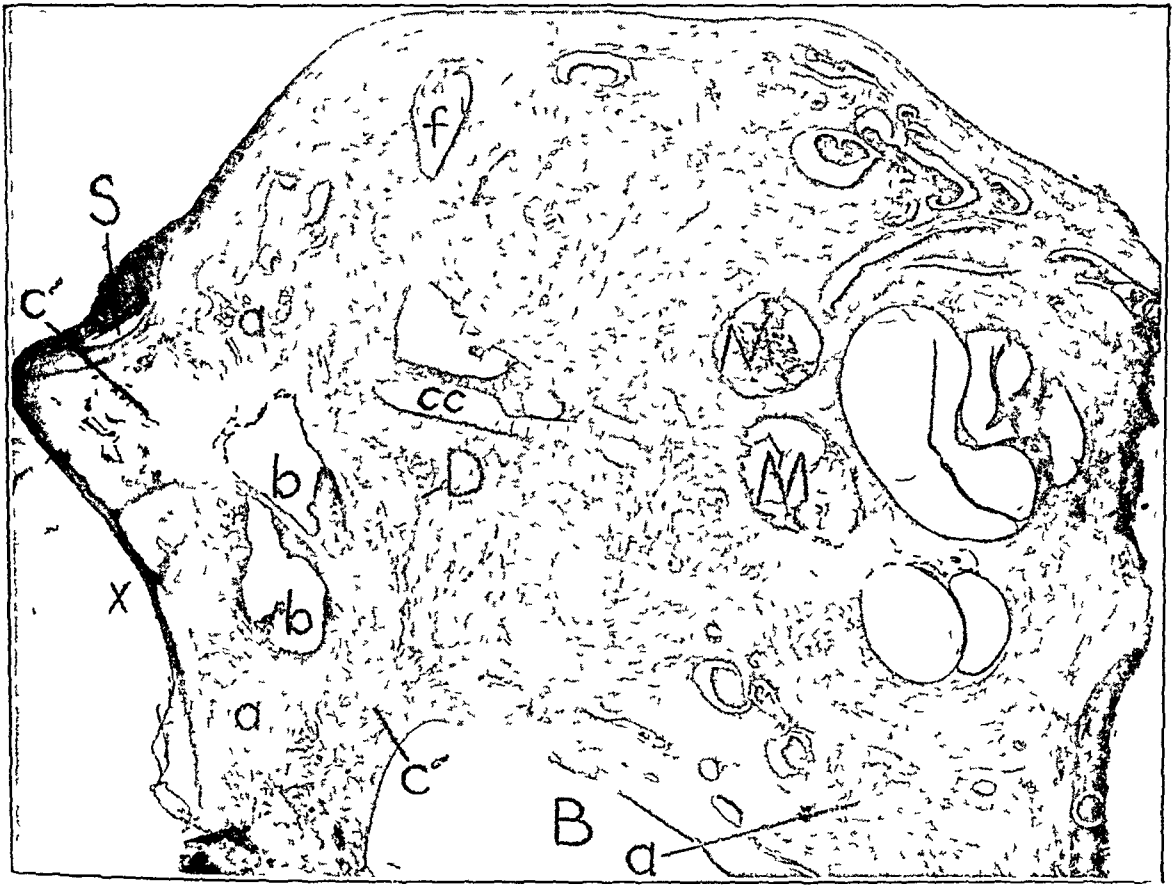


Fig 2—Section through the cochlea, carotid canal (C), internal meatus (M), crus commune (cc), frontal semicircular canal (f) and bulb of the jugular vein (B), on the left side. D indicates ductus endolymphaticus, presented in figures 4 and 5 in higher magnification, S, superior petrosal sinus, showing purulent thrombophlebitis, a, formation of connective tissue subsequent to osteitis of the petrous bone, b, frank pus within pneumatic cells, and c', newly formed bones subsequent to osteitis of the petrous bone. In r the osteitis had reached the dura of the posterior cranial fossa.

irregular. The frame of the oval window was normal as was the annular ligament. The floor of the bony canal of the facial nerve, above the oval window, showed an erosion which was filled with connective tissue, this erosion did not extend into the facial canal. The recess of the round window was narrow, owing to the swollen mucosa, the edema of which was not as evident as that in the oval window. The membrane of the round window was normal and bulged slightly

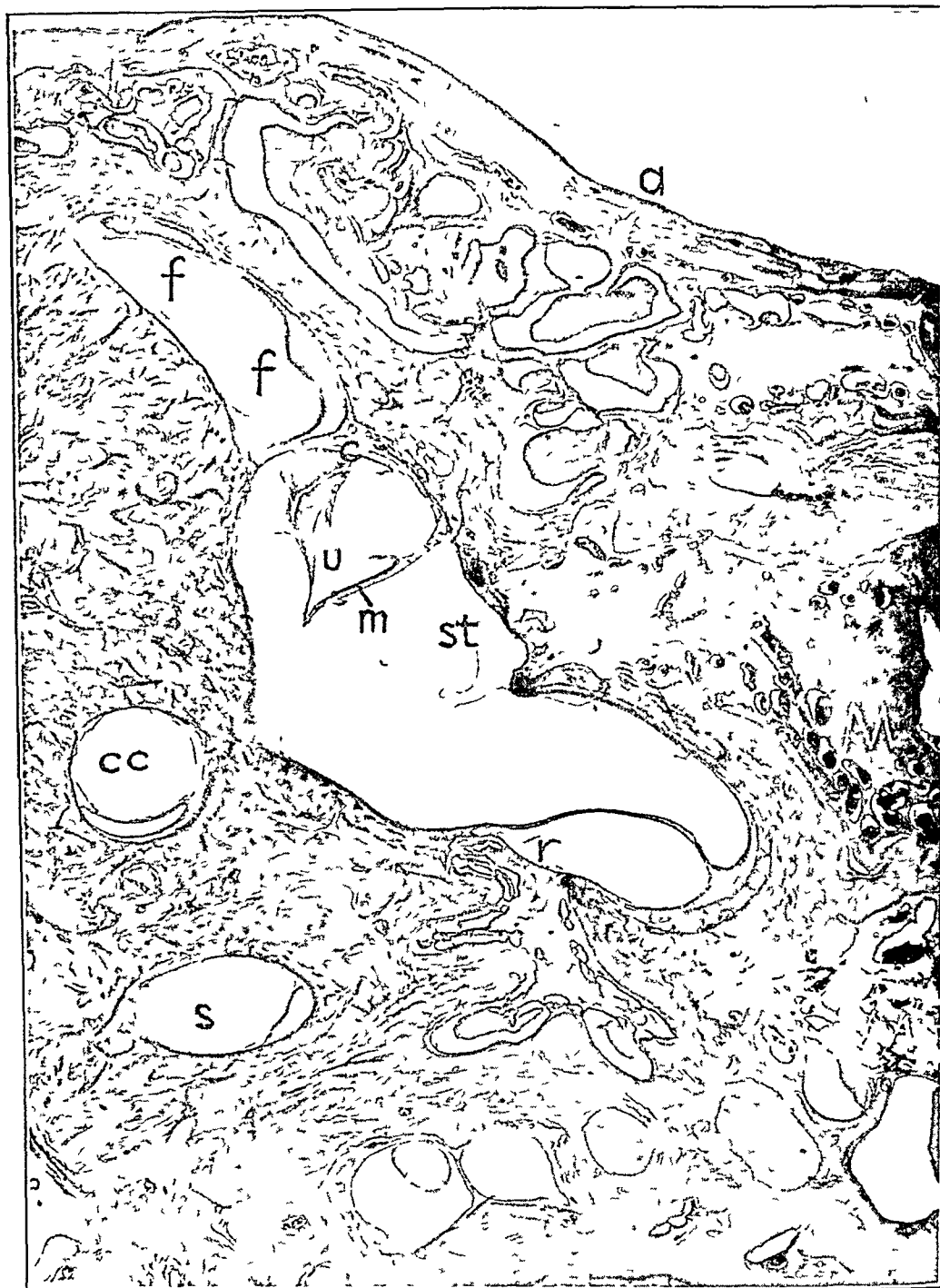


Fig 3—Section through the oval window, round window (*r*), vestibular portion of cochlea, utricle (*u*), frontal semicircular canal (*f*), crus commune (*cc*) and sagittal semicircular canal (*s*), on the left side *M* indicates tympanic mucosa, markedly swollen and filling the recesses of both windows, *m*, macula utriculi, *c*, crista frontalis, *st*, stapes, slightly displaced toward the tympanic cavity, and *a*, connective tissue and capillary between the dura of the middle cranial fossa and the mucosa of an infected pneumatic cell

toward the middle ear. The antrum was narrowed by edematous mucosa, the horizontal semicircular canal was normal. The pneumatic cells of the remnant of the mastoid process were filled with pus. There was osteitis of the superior and posterior wall of the bony external canal.

The ductus and saccus endolymphaticus formed a tube, the axis of which ran almost parallel to the axis of the crus commune. Medialward the duct turned toward the posterior cranial fossa so that the axis formed an angle of less than 90 degrees with the axis of the crus commune. At the curve⁵ the endolymphatic duct, as well as the vestibular aqueduct, formed an ampulla-like dilatation (figs 2 and 4), which became rapidly narrower toward the sacculle and which abruptly changed into a slitlike lumen toward the cranial opening of the aqueduct. In the area of the dilatation, the structure of the endolymphatic duct was similar to the structure of a part of the endolymphatic duct in guinea pigs, the latter structure Guild⁶ called *pars intermedia*, although in the presented case the epithelium in this area was cubical, not columnar, as it is in guinea pigs (fig 4).

Close to the sacculle the wall of the endolymphatic duct consisted of firm connective tissue, which served as a periosteum. Toward the lumen the connective tissue became loose and edematous and was covered by low cubical epithelium, of the same kind as Siebenmann⁷ noted in the normal endolymphatic duct in man. In the comparatively large lumen were erythrocytes and lymphocytes. In the ampulla-like dilatation there was, again, the periosteum, which originated from the dura of the posterior cranial fossa (fig 4c). Within the periosteum was a small number of dilated capillaries, presenting a perivascular infiltration. In addition, there were masses of yellow and brown pigment, apparently remnants of hemorrhages, although not verified by a test for iron. The osseous walls of the vestibular aqueduct occasionally showed lacunas, indicating a bone absorption of low intensity. The rest of the osseous wall was separated from the periosteum by a fine blue *Grenzschiede*. In this area the walls of the endolymphatic duct formed numerous villi and polypoid excrescences, which bulged into the lumen of the duct (fig 4). Frequently, two villi facing one another fused, after having lost their epithelium. This caused the lumen of the duct to be divided into several small cavities, which were either empty or filled with serous exudate. The epithelium was low and cubical.

The villi consisted of loose connective tissue, which contained a glasslike edema fluid, or of areolar tissue, which was crowded with specific cells (fig 4). The cells were of various sizes, were round or oval and showed much cytoplasm, crowded with yellow granules. The nucleus was comparatively small, contained a

5 The osseous channel of the vestibular aqueduct starts at the posterior surface of the petrous bone and runs within the petrous bone in an oblique direction, mesialward and upward toward the area where the anterior and the posterior semicircular canal fuse and form the crus commune. In this area the channel forms a curve behind the crus commune and runs in an oblique direction downward toward the junction of the crus commune with the osseous vestibulum. The osseous channel harbors the membranous endolymphatic duct, which takes the same course as the osseous channel.

6 Guild, S. R. Observations upon the Structure and Normal Contents of the Ductus and Saccus Endolymphaticus in the Guinea-Pig (*Cavia Cobaya*), *Am J Anat* 39 1, 1927.

7 Siebenmann, F. Anatomische Untersuchungen über den Saccus und Ductus endolymphaticus beim Menschen, *Beitr z Anat, Physiol, Path u Therap d Ohres* 13 59, 1919.

considerable amount of chromatin and was either centrally or eccentrically located. These cells were undoubtedly phagocytes. They were loosely scattered between the connective tissue fibers (fig 5), which were torn by the edema, or they were piled up and may have produced bulging of the epithelium toward the lumen, or they showed an epithelium-like arrangement. They did not accumulate around the dilated blood vessels, and they almost disappeared where there was perivascular infiltration of lymphocytes or recent hemorrhage. They were not to be found in the lumen of the duct.

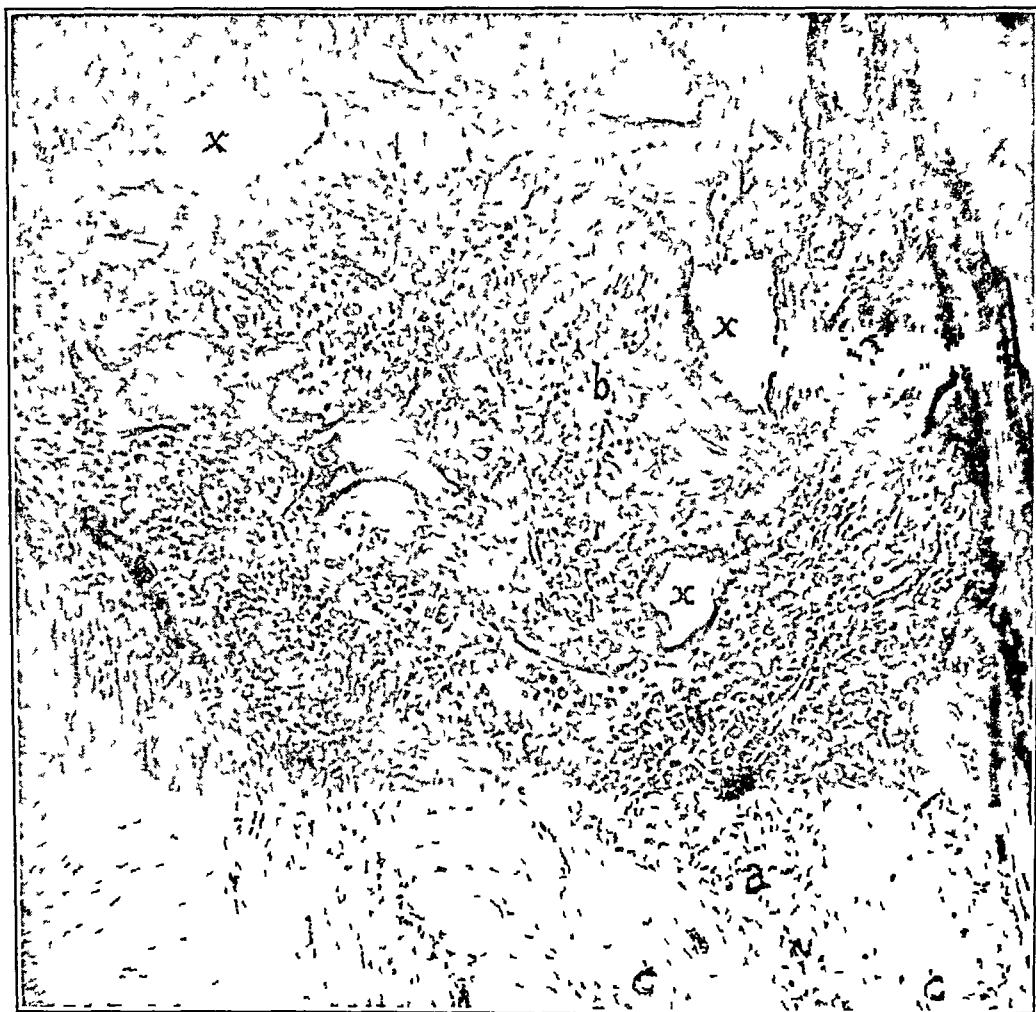


Fig 4—Ductus endolymphaticus of figure 2 in higher magnification. The lumen of the duct is obliterated, to a great extent, by pronounced edema of the walls (*b*). Only remnants of the lumen (*i*), partially filled with serous exudate, are noticeable. The edematous walls of the duct are filled with gitter cells, which are presented in figure 5 in higher magnification. The gitter cells seem to accumulate toward the funnel-like narrowing of the duct (*a*), where they enter the narrow cerebral portion of the duct. Firm connective tissue (*c*) surrounds the cerebral portion of the duct.

Toward the dura, the vestibular aqueduct became narrow, and the endolymphatic duct presented a slitlike lumen. A great number of the phagocytes entered this part of the duct, and, because there was not much space available, the cells were

firmly pressed against each other (fig 4) Farther cranialward the wall of the duct consisted of firm connective tissue of dural origin In this part there were only a few phagocytes and several corpora arenacea The lumen and the walls of the endolymphatic sac proper did not contain any pathologic material

Right Temporal Bone Here, likewise, was a severe infection of the apex of the pyramid and of the perilabyrinthine cells (fig 1) The area of destruction had essentially the same localization with respect to the internal ear as it had on the left side, but apparently this area was not as extensive as it was on the left Furthermore, the area consisted almost exclusively of firm connective tissue and

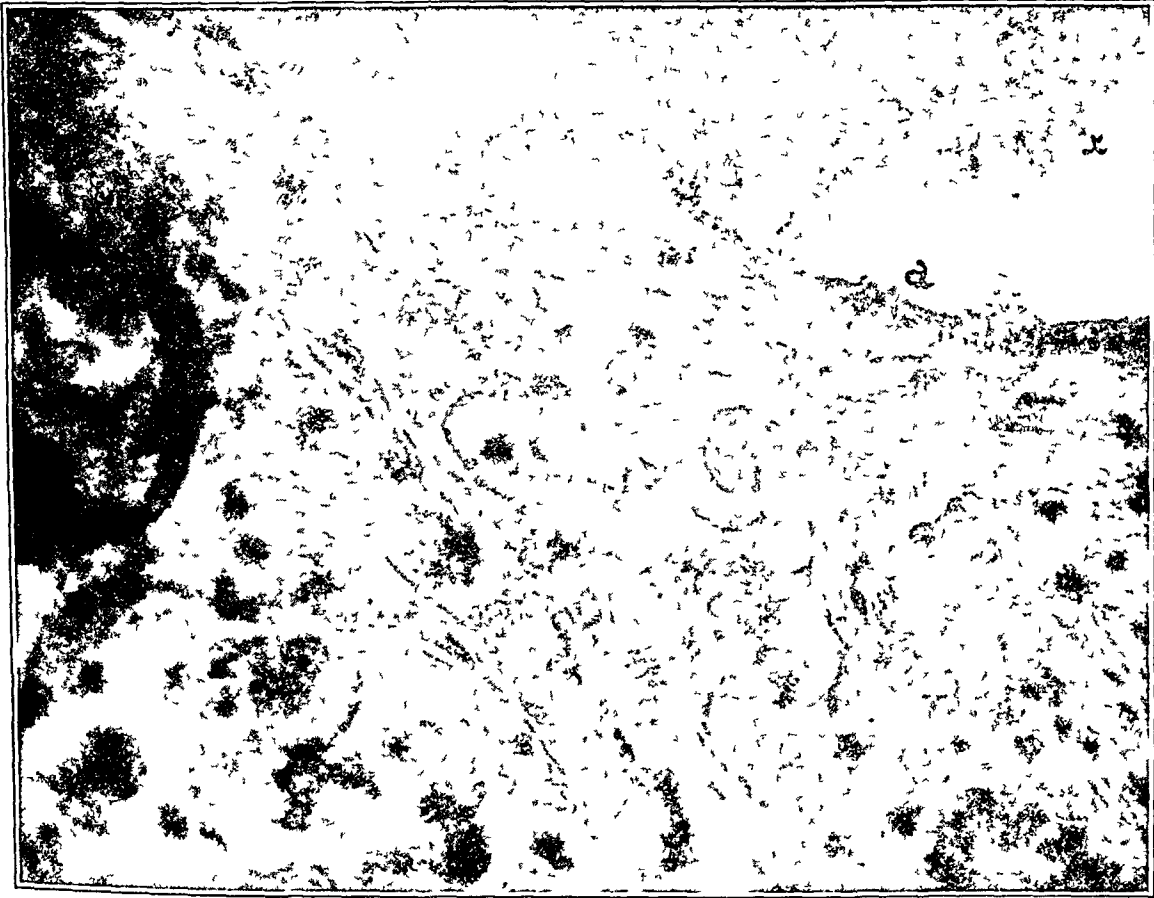


Fig 5—Gitter cells within the membranous wall of the endolymphatic duct, *a* indicates epithelium, *r*, exudate within the lumen of the duct

newly formed bone There were only a few small abscesses within the connective tissue In the cochlea there were essentially the same changes as on the left side In the tube there was pus and the mucosa was considerably swollen The epithelium of the mucosa was normal

Comment—The following pathologic changes were seen on both sides (*a*) acute infection of the mucosa of the tube and tympanic cavity, (*b*) extensive osteitis of the apex of the pyramid and of the periosteal layer of the capsule of the internal ear, which was more pronounced on the left side than on the right, with large abscesses on the left, (*c*) acute purulent infection of the perilabyrinthine cells, and (*d*) acute serous labyrinthitis

Of particular interest was the presence of a great amount of phagocytes in the areolar tissue of the wall of the duct (figs 4 and 5) The cytoplasm of the cells was filled with granular yellow material Although no specific staining had been performed, it is likely that the cells contained lipids Cells of this type are known to arise from the reticuloendothelial system, present in all types of tissue In the brain, these cells are produced by the microglia (mesodermal) and the perivascular histiocytes and are called gutter cells, or *Körnchenzellen* In the ear, these cells were not particularly studied, but they are commonly seen in the exudate of acute otitis media and of serous labyrinthitis

In the lumen of the endolymphatic duct of guinea pigs, Guild⁶ noted numerous cells, among them phagocytes, which morphologically were similar to the phagocytes in the presented case Siebenmann⁷ emphasized that in the endolymphatic duct in man there are no abnormal cells in the lumen or in the subepithelial tissue For this reason the phagocytes in the presented case must be considered pathologic, and the conclusion must be drawn that the phagocytes accomplish the resorption of the serous exudate in the internal ear In favor of this concept are the following facts 1 In the acute stage of serous labyrinthitis, phagocytes do appear in the internal ear 2 In the presented case there had been acute serous labyrinthitis, but at the time of death the exudate had disappeared to a great extent from the inner ear Thus, the case proves that in serous labyrinthitis the exudate is carried away from the internal ear by phagocytes¹⁰ It is obvious that the phagocytes which carry the exudate arise in the internal ear from the reticuloendothelial system, as they do in the rest of the body This is proved by the findings in Gaucher's disease, in which these phagocytes arise from the histiocytes in the marrow spaces of the temporal bone (Brunner¹¹)

The presence of phagocytes in the subepithelial tissue at the curve of the endolymphatic duct, on the one hand, and the absence of cells and of a massive exudate in the inner ear, on the other, indicate that there must be a flow of the phagocytes, or of the exudate or of both from the internal ear toward the endolymphatic sac This flow was temporarily stopped at the curve of the duct because there was a dilatation which was continued toward the cranial fossa by an isthmus-like narrowing of the endolymphatic duct This concept explains the

10 It is likely that these phagocytes are very frail elements, like the gutter cells in the brain They make their appearance when the serous labyrinthitis is going to subside, and they probably disappear rapidly when the inflammation has subsided

11 Brunner, H Ueber das Vorkommen von Gaucherzellen im Felsenbein, *Ztschr f Hals-, Nasen- u Ohrenh* 22 60, 1928

absence of phagocytes in the part of the endolymphatic duct which extended from the vestibule to the curve of the duct, although there was considerable edema of the wall in this part of the duct

From these findings the following conclusions must be drawn. In serous labyrinthitis there is a flow from the internal ear toward the endolymphatic sac. This flow carries the inflammatory products away from the inner ear. It is a question of secondary importance whether the inflammatory products are resorbed by phagocytes within the inner ear and the phagocytes are then carried into the endolymphatic duct, or whether the exudate flows into the duct and is resorbed by phagocytes which arise in the wall of the duct. The latter concept seems more likely. In either case, it is certain that in serous labyrinthitis a resorption takes place in the endolymphatic duct. This concept is in agreement with the view of many investigators, particularly that of Guild,¹² concerning the function of the normal endolymphatic duct, although it must be kept in mind that the observations made on pathologic cases do not necessarily permit conclusions concerning physiologic conditions.

Serous labyrinthitis is not infrequent in scarlatina otitis. Nager,¹³ Mayer,¹⁴ Manasse,² Zange¹⁵ and others have reported cases of this type. Nager was the first to show that in these instances there is no fistula in the window or in other parts of the lateral wall of the labyrinth, the infection travels, rather, from the tympanic cavity through the inflamed but not perforated membranes of the windows into the internal ear. According to the terminology of Ruttin,³ this type of labyrinthitis is, therefore, called diffuse serous induced labyrinthitis.

The presented case differs in several aspects from the reported cases. In this case there was severe petrositis, which eventually may be considered the source of the serous labyrinthitis. This concept, however, is not correct, at least not for the left side, which was thoroughly examined, for the petrositis had involved almost exclusively the periosteal layer of the bony capsule, and thus the entire endochondral layer intervened between the area of the petrositis and the internal ear. Moreover, in the other cases the serous labyrinthitis was caused almost exclusively by the necrotic type of otitis complicating scarlatina. In this case there was no necrotic otitis media, despite the associated nasal diphtheria. On the contrary, the tympanic mucosa was extremely

12 Guild, S. R. The Circulation of the Endolymph, *Am J Anat* **39** 57, 1927

13 Nager, F. Eine statistische Studie über die scarlatinöse Erkrankung des Gehörorgans, Wiesbaden, J. F. Bergmann, 1908

14 Mayer, O. Zur Entstehung der sogenannten Labyrinthitis serosa im Verlaufe akuter Mittelohrentzündungen, *Monatsschr f Ohrenh* **43** 1909, 1909

15 Zange, J. Pathologische Anatomie und Physiologie der mittelohrentzündenden Labyrinthentzündungen, in Korner, O. Die Ohrenheilkunde der Gegenwart und ihre Grenzgebiete. Wiesbaden, J. F. Bergman, 1919, vol 10

edematous (fig 3), and there was no defect of the epithelium except in those areas where operation was performed. The epithelium was higher than is usual with normal conditions, a common finding in acute otitis media. These observations prove that in scarlatina serous labyrinthitis may occur without being caused by necrotic otitis media.

Ultimately, in most of the reported cases the annular ligament and the membrane of the round window were at least partially inflamed or necrotic, and there was severe inflammation in the area of the window. This indicates that in the reported cases there was perhaps a secondary diffuse serous labyrinthitis, in contradistinction to this case, in which, on the left side, induced serous labyrinthitis was discovered. The question is whether the annular ligament and the membrane of the round window, which at autopsy were found to be normal (fig 3), had ever been inflamed during the long course of the illness. This cannot be answered, however, if they had been inflamed, evidence had completely disappeared at the time of autopsy.

The symptoms of induced diffuse serous labyrinthitis consist of dizziness and nystagmus to the opposite side, at least of second degree intensity. There is no symptom of fistula. Hearing and caloric and turning reactions are not entirely absent, or, if they are, they return completely or partially after the labyrinthitis is cleared. In the presented case the symptoms were different. There was, immediately following the paracentesis, bilateral diminution of hearing, which within four days increased to complete deafness on both sides. Labyrinthine symptoms—dizziness and spontaneous nystagmus—were absent, and the caloric reaction was diminished on both sides but was not absent. This elicitation of the caloric reaction suggested the diagnosis of serous labyrinthitis, because in purulent labyrinthitis the caloric reaction cannot be elicited. This diagnosis was confirmed by the microscopic examination. For this reason the presented case proves the following points:

- 1 Acute deafness in scarlatina may be caused by bilateral otitis media plus bilateral diffuse serous labyrinthitis.

- 2 The otitis media which causes the serous labyrinthitis may be common acute otitis, it need not be necrotic otitis.

- 3 The serous labyrinthitis which causes the deafness may be an induced labyrinthitis, i. e., labyrinthitis caused by the passage of toxins through the intact windows.

- 4 In cases of induced serous labyrinthitis, the cochlear nerve is normal (on section, with the hematoxylin-eosin and Van Gieson stains), and the spiral ganglion is almost normal.

- 5 An induced serous labyrinthitis may cause deafness but may fail to produce spontaneous labyrinthine symptoms.

The fact that serous labyrinthitis eventually causes complete deafness was emphasized by Herzog,¹⁶ who asserted that even inflammatory changes of the endolymph not associated with destruction of the sensorial epithelium may cause complete and acute deafness. Herzog's observation was confirmed by Ruttin, Neumann and others, but it was added that in these instances the acute deafness is associated with acute labyrinthine symptoms and that the complete deafness is usually transitory. In the presented case there were no acute labyrinthine symptoms. This is unusual, but it is conceivable. The inflamed endolymph in serous labyrinthitis exerts various kinds of influence on the sensorial cells: (a) a mechanical influence, due to pressure on the sensorial cells, (b) a toxic influence, due to toxins within the endolymph, and, perhaps, (c) a chemical influence, due to increased content of proteins in the endolymph. It cannot be predicted to which degree these factors will damage the sensorial organs in an individual case, or which sensorial organs they will injure more and which they will injure less. This may be the reason for the variability of clinical symptoms in serous labyrinthitis.

The question whether hearing in cases of serous labyrinthitis must necessarily be restored is related to the concept of serous labyrinthitis in general. There is by no means unanimity on this concept. Some otologists consider serous labyrinthitis a morbid entity, others regard it simply as the prodromal stage of a purulent infection. Personally, in agreement with a great many otologists, I have always considered serous labyrinthitis (like serous meningitis) a morbid entity which, even after prolonged duration, does not necessarily change into purulent labyrinthitis. This takes well into consideration the fact that purulent labyrinthitis eventually may set in, producing a serous exudate. However, in such instances the patient is severely ill, the meninges are very soon involved and the change from serous to purulent exudate is rapid. The presented case proves the accuracy of this view. The child lived for more than five weeks after the onset of deafness. Nevertheless, the labyrinthitis was serous and not purulent, although there had been enough time for a change to occur from serous to purulent exudate and although no sulfonamide drugs or antibiotics were given.

The concept of serous labyrinthitis as a morbid entity does not imply that there must invariably be a restoration of hearing. I believe, rather, that the serous labyrinthitis *per se* may cause not only transitory but permanent deafness, although partial, and occasionally complete, restoration of hearing is more frequent. In this case hearing was not restored during the five and one-half weeks of illness before the child died. The question is whether hearing would have been restored had

¹⁶ Herzog, M. *Labyrintheiterung und Gehoer*, Munich, J. F. Lehmann, 1907.

the child lived. The answer is purely speculative. The facts that within a period of more than five weeks only moderate atrophy of the ganglion of the basilar portion had developed and that during this period nothing occurred to indicate an organization of the exudate render it likely that hearing would have been restored, though probably not to a normal extent. In fact, this is what frequently happens in cases of survival.

CONCLUSIONS

1 In serous labyrinthitis the exudate is carried away from the internal ear—at least to a great extent—by phagocytes.

2 In serous labyrinthitis resorption of inflammatory products takes place in the endolymphatic duct.

3 In scarlet fever serous labyrinthitis may occur without being caused by necrotic otitis media.

4 Acute deafness in scarlatina may be caused by bilateral otitis media plus bilateral diffuse serous labyrinthitis.

5 The serous labyrinthitis may be an induced labyrinthitis, *i. e.*, labyrinthitis caused by the passage of toxins through the intact windows.

6 An induced serous labyrinthitis may cause deafness but may fail to produce spontaneous labyrinthine symptoms.

7 Serous labyrinthitis *per se* may cause not only transitory deafness but also permanent diminution of hearing.

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UNILATERAL PARALYSIS OF THE LARYNX

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THIS article is an attempt to correlate the material published since 1913 on the subject of unilateral paralysis of the larynx. The observation of 3 cases of unilateral laryngeal paralysis within one month, in all 3 of which the left cord was involved and the etiologic factors were different, suggested a survey of the literature on this subject, which, on investigation, proved to be voluminous but widely scattered. The following paragraphs attempt to bring together the pertinent facts discovered.

There are five types of laryngeal paralysis: (1) congenital, (2) central, (3) peripheral, (4) myopathic and (5) psychogenic. The congenital type which is present at birth, is rare and is bilateral. The central type, which is comparatively rare, is divided into the cortical and bulbar subgroups. Paralysis of cortical type is very rare, and, since the center for the larynx in the cortex is bilateral, a bilateral lesion in this area would be necessary to produce a paralysis of the larynx and the paralysis would be bilateral. The second form of central paralysis is that due to pathologic changes of the bulbar region and the jugular foramen. The peripheral type may be produced by any lesion affecting the vagus nerve down to and including the recurrent nerve, the myopathic and psychogenic types are self explanatory. It is with the bulbar and peripheral types that this paper is concerned.

Unilateral paralysis of the recurrent laryngeal nerve is not uncommon, unilateral paralysis of the larynx due to involvement of the medulla or jugular foramen is rare. Hall¹ in 163 cases found that only 10 were due to a lesion of the medulla or associated cranial nerves. Thomson, cited by New,² found that in a series of 360 cases there was only 1 attributable to this cause, and this case was due to an extra-cranial growth involving the vagus close to its exit from the foramen.

Read before the Philadelphia Laryngological Society, April 4, 1949

1 Hall, H D, Ferrier, D, and Permawan, W, in discussion on the Etiology of Unilateral Paralysis of the Recurrent Laryngeal Nerve, Proc Roy Soc Med 6 139, 1913

2 New, G B, and Childrey, J H. Paralysis of Vocal Cords. Study of Two Hundred and Seventeen Medical Cases, Arch Otolaryng 16 143 (Aug) 1932

Guder and Dufour,³ in a series of 63 cases, found none that could be called bulbar in nature

The etiologic factors involved in the production of laryngeal paralysis may be grouped into four major divisions (1) the nervous system, (2) diseases of the respiratory tract, (3) circulatory diseases, (4) diseases of the adjacent areas (Lederer)⁴ This classification is much like that of Hall,¹ who listed ten neurogenic causes and fifteen that are not neurogenic but cause pathologic conditions of the recurrent nerves Lederer listed sixteen causes due to primary disease of the nervous system

These may be considered in more detail The nervous system affords numerous variations as, for instance, trauma due to accidents and injuries with dangerous weapons, the effects of which may be direct or indirect, neuritis, both exogenous and endogenous—the former caused by hair dyes, drugs, etc., and the latter by scarlet fever, influenza, malaria, typhoid, syphilis and the like General nervous system disorders include progressive bulbar palsy, tumor of the brain, multiple sclerosis, syringomyelia, tabes, dementia paralytica, central nervous system syphilis, bulbar poliomyelitis, hemorrhage of the brain and the bulb with softening of nervous tissue, and sympathetic nervous system dysfunction

The diseases of the respiratory tract include tumors of the lung and tuberculosis of the apex of the lung causing a thickened pleura, enlarged lymph nodes of the bronchial tree and mediastinal tumors

The circulatory conditions most frequently observed are enlarged heart causing a dilated ventricle or left auricle to press on one of the recurrent nerves, aneurysm of the aorta, pericarditis mitral stenosis and pericardial adhesions

Diseases of the adjacent areas consist of tumors of the neck—retrosternal and intrathoracic thyroid, and malignant and benign tumors of the thyroid gland—and Hodgkin's disease While thyroid surgery cannot be classed as a disease, injury of the recurrent nerves during an operation on the gland is one of the main factors in paralysis of the larynx

Clerf⁵ has stated "Paralysis of vocal cord is rarely caused by disease of the larynx The causes must be found within the thoracic cage and mediastinum, neck or cranial cavity" Even after the most careful study a great many of these cases remain undiagnosed as far as the etiologic agent is concerned

3 Guder and Dufour, cited by Permawan, in discussion on the Etiology of Unilateral Paralysis of the Recurrent Laryngeal Nerve, *Proc Roy Soc Med* 6 152, 1913

4 Lederer, F Diseases of the Ear, Nose and Throat Principles and Practice of Otorhinolaryngology, ed 5, Philadelphia, F A Davis Company, 1946, p 751

5 Clerf, L H Paralysis of the Larynx, *J Michigan M Soc* 46 441 (April) 1947

The left recurrent nerve is the one most frequently involved in unilateral paralysis in the ratio of about 4 to 1 because of its peculiar anatomy. Hall⁶ stated that "if malignant disease of the esophagus be excluded, it may be baldly stated that the right recurrent nerve is hardly ever paralysed as a result of pressure in the mediastinum."

In summary of the etiologic agents causing this condition, it is probable that hemorrhage of the bulb is the commonest cause of the bulbar type of lesion, carcinoma of the upper third of the esophagus the cause of a lesion in the hypopharynx and aneurysm of the aorta the commonest cause of a lesion in the lower part of the neck, with surgical injury to the recurrent nerve in the neck following closely.

With the foregoing etiologic factors in mind, it is evident that any one or all three of the functions of the larynx will be affected in paralysis of the organ—respiration, phonation and deglutition.

According to New,⁷ in unilateral paralysis due to injury to the recurrent nerve the affected cord is in the median or paramedian position. The cord is bowed, relaxed and lower than its fellow. If the paralysis is due to injury of the recurrent nerve only, the paralyzed cord is found in the median position, but if it is due to injury of the vagus nerve the cord (injury at the jugular foramen) is found in the cadaveric position. The symptoms vary with the type of paralysis and the extent. In unilateral lesions the voice is seldom impaired, the only alteration being a quality of coarseness which becomes more pronounced after prolonged use. There is usually no dyspnea unless the patient exerts himself more than normal, there being enough opening of the glottic chink for normal respiration. According to Semon's Law, the abductor muscles are first affected and the cord lies in the median position. Then comes a degeneration of the adductor muscles, and the cord recedes to the paramedian position when both sets of muscles are incapacitated. The normal cord attempts to cross the midline on phonation. This is considered an attempt of the physiologic sensibility of the larynx to compensate for the injured cord.

The prognosis of paralysis of the larynx is variable. Mulligan⁸ has stated that in patients with unilateral paralysis following thyroidectomy the voice definitely improved in six weeks but after prolonged use of the voice only a whisper could be elicited. Complete recovery was seen in only 1 case. New and Childrey⁹ stated that a cord fixed medianly may recover completely but will remain fixed medianly and a

6 Hall, Ferrier and Permawan,¹ p. 142.

7 New, G. B., and Childrey, J. H. Paralysis of Vocal Cords. Study of Two Hundred and Seventeen Medical Cases, *Arch Otolaryng* **16** 145 (Aug.) 1932.

8 Mulligan, E. J. Prognosis of Laryngeal Paralysis Following Thyroidectomy, *Arch Otolaryng* **35** 732 (May) 1942.

9 New and Childrey,⁷ p. 155.

cord in the cadaveric position may recover but in a few months will swing to the median position. New found that position of the cords had some relation to the time of recovery. With a cord in the midline the recovery time averaged seventeen months, whereas with the cord in the cadaveric position the recovery time was only ten and one-half months. Smith, Lambert and Wallace, writing in the *Edinburgh Medical Journal*,¹⁰ took issue with New and Childrey on the position of the cord. In the majority of their cases the cord was in the cadaveric position, and they felt that it is difficult to conceive that a concurrent superior laryngeal paralysis is always present to account for this, as New and Childrey have postulated. They also stated that the commonest causes of paralysis of the recurrent nerve in their cases were aneurysm of the aorta and mediastinal tumors, and they felt that Childrey and New were too optimistic regarding the ultimate outcome in these cases. Suehs¹¹ analyzed the records of 270 cases of laryngeal paralysis over a period of eighteen years and concluded that carcinoma was the commonest cause of the unilateral type, that surgical procedures in the thyroid gland were the most frequent cause of the bilateral type and that, whatever the cause, the prospect of recovery is poor at best but increases somewhat if the etiologic agent can be discovered.

Imperator¹ and Burger have thoroughly covered the subject of the associated paralysees of the larynx. Imperator¹² mentioned three variations of the Avellis syndrome. He stated that the original syndrome of Avellis consisted of the following conditions: (1) paralysis of the vocal cord and soft palate and partial paralysis of the constrictor muscles of the pharynx and esophagus, (2) loss of pain and temperature sense of the contralateral side of the body below the interauricular line with retention of all other somatic sensibilities, and (3) endarteritis. In describing the variations of the syndrome, he mentioned that of Schmidt, in which to the already described dysfunctions there is added a lower motor neuron paralysis of the sternomastoid and trapezius muscles. In addition to these findings of Avellis and Schmidt, if paralysis and atrophy of the ipsilateral side of the tongue are added, the result is Jackson's syndrome. If lateropulsion and loss of sensibility of the homolateral side of the face are added, Tapia's syndrome is present.

10 Smith, A. B., Lambert, V. F., and Wallace, H. L. Paralysis of the Recurrent Nerve. Survey of Two Hundred and Thirty-Five Cases, *Edinburgh M. J.* **40** 344 (July) 1933.

11 Suehs, O. W. Paralysis of the Larynx. Study of Two Hundred and Seventy Cases, *Texas State J. Med.* **38** 665 (March) 1943.

12 Imperator, C. J. Syndrome of Avellis. Report of Three Cases, *Arch. Otolaryng.* **1** 277 (March) 1925.

Burger,¹³ in the Semon Lecture of 1934, thoroughly discussed the whole subject of the associated paralyses of the vocal cord and suggested that a classification into four syndromes on an anatomic basis would be helpful in understanding the various findings. This is much like that cited in Lederer's textbook.

The existence of associated paralyses of the vocal cord is of great importance for localization of lesions, but it is seldom that more than a rough distinction between a high and a low injury of the vagus and a distinction between an injury of the recurrent and of the vagus nerve are discerned. In pure recurrent nerve paralysis the cord is the only structure affected, in lesions of the vagus nerve one may find in addition to paralysis of the cord, hemianesthesia of the larynx, hemiparalysis of the palate, acceleration of the pulse, abolition of the oculocardiac reflex and associated paralyses already described.

Burger's Classification of Associated Paralyses

	Syndrome	Nerves Involved	Vagus Involvement
I	Bulbar nerve syndrome	Fifth to twelfth cranial	High
II	Jugular foramen syndrome	Ninth to twelfth cranial, sympathetic	High
III	Parapharyngeal space syndrome	Ninth, tenth, seventh, twelfth cranial, sympathetic	Low
IV	Vocal cord-diaphragm syndrome	Tenth cranial, phrenic, sympathetic	Low

It was thought originally that the various paralyses of the associated type were due to hemorrhage into the nucleus ambiguus in the medulla and into surrounding nuclei, but it was thought impossible that such a thing could happen without affecting other structures in the neighborhood, particularly when one takes into consideration the large extent of the ninth, tenth, eleventh and twelfth nerve nuclei.

No other class of paralysis of the bulbar nerves is so typical as that of the ninth, tenth and eleventh. In searching for a cause of this syndrome, the lateral sinus and its thrombosis come to mind as the first possibility, yet the literature on sinus thrombosis has never mentioned the three complete, according to Burger.¹⁴

It is evident that it would be very easy to have trouble in the region of the jugular bulb. Pachymeningitis of the sinus, involving the bulb, too tight packing of a mastoid wound after an operation on the lateral sinus, tumors of the parapharyngeal space, and lesions of the external and middle ear—all have their place in the causation of this entity.

¹³ Burger, H. Associated Paralyses of Vocal Cord (Semon Lecture, 1933), *I Laryng & Otol* **49** 1 (Jan) 1934.

¹⁴ Burger,¹³ p. 15.

REPORT OF CASES

The patients whose cases are briefly reported were all seen in the outpatient laryngeal clinic of the Philadelphia General Hospital

CASE 1—A man complained of hoarseness of two years' duration and inability to use his left shoulder properly. On examination there was a complete paralysis of the left cord with slight bowing, and the cord itself was slightly off the median line. The soft palate was not paralyzed but appeared to be lacking in sensitivity. The left trapezius muscle showed atrophy, and there was some limitation of movement. There was a mass in the left supraclavicular space 1 inch (2.5 cm) above the clavicle. The patient was referred to the radiology department for roentgenograms of the skull, chest and cervical and thoracic portions of the spine and from there was sent to the neurologic department for examination. The following report was submitted by the neurologist:

"The cranial nerves are normal except for a questionable miosis of the left eye (anisocoria) and a questionable right central seventh. There is wasting of the left trapezius, but only a little loss of motor power. The sternomastoid on the left is not involved. Sensory and cerebellar functions are normal. There is no weakness of the extremities, deep tendon reflexes are normal, there is a slight wasting of the left triceps muscle with no functional loss. There seems to be a round firm mass in the left supraclavicular fossa. The paralysis of the left cord plus the atrophy of the trapezius and tricep muscles can be explained by a local mass lesion. The questionable Horner syndrome on the left gives rise to a question of a sulcus neoplasm. Lack of involvement of the sternomastoid muscle and absence of long tract signs make a central lesion unlikely."

CASE 2—A man, 76 years of age, complained of hoarseness and dyspnea on exertion, with reduction of the voice to a whisper when he talked for any length of time. Examination revealed paralysis of the recurrent laryngeal nerve on the left side, with no evidence of any other local lesion. He stated that his trouble had started two weeks prior to coming to the hospital. A roentgenogram of the chest showed a large saccular aneurysm involving the distal horizontal and upper descending portions of the aorta. There were atheromatous plaques in the sac. The trachea was displaced to the right and the left side of the diaphragm elevated.

CASE 3—A 26 year old woman sustained an injury to the neck in an automobile accident on Feb 29, 1948. She was admitted to the hospital, and it was noted at the time of admission that she had had an injury to the larynx with swelling of the left arytenoid muscle and vocal cord and dysphagia. A roentgenogram of the neck at that time did not reveal the nature of the injury to the larynx. There was considerable edema of the whole larynx, especially the left side. On March 11 the right side of the larynx was beginning to move better, but the left side was very sluggish and the ventricular band bulged into the interior of the larynx. The edema was clearing. She was dismissed from the hospital on March 12 with swallowing nearly normal, laryngeal edema decreased and hoarseness still present.

When she was seen again, one week later, the voice was still a whisper. The left cord was completely paralyzed and just off the midline. There was still some swelling of the ventricular bands, but the left band had receded from the interior of the larynx. There was a definite crepitus felt along the area of the junction of the thyroid and cricoid cartilages, and this was the probable site of injury of the left recurrent nerve causing the paralysis. Roentgenologic evidence of laryngeal injury was unobtainable.

SUMMARY AND CONCLUSIONS

Some of the literature dealing with paralysis of the larynx has been reviewed, and 3 typical cases of unilateral laryngeal paralysis are reported

Unilateral paralysis is largely a medical problem. Exact diagnosis of the cause of paralysis is not made in 20 per cent of the cases. The therapy of this condition is unsatisfactory, it should be directed toward correction of the lesion causing the paralysis if it can be found. The prognosis is poor at best but is improved somewhat if the etiologic agent is known and proper treatment can be instituted.

Union Trust Building

IDIOPATHIC PARALYSIS OF THE VOCAL CORD

Fixation of the Vocal Cord Without Anatomic Lesion

EMIL GLAS, M D, D O L *

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UNILATERAL paralysis of the vocal cord producing hoarseness and occasionally narrowing of the glottis is frequently seen by the laryngologist. In most patients with this condition the inferior laryngeal branch of the vagus nerve has been injured by an organic lesion. The left inferior laryngeal (recurrent laryngeal) nerve is more frequently affected than the right because of its greater anatomic complications. Thus, as it courses about the arch of the aorta, the recurrent laryngeal nerve becomes susceptible to pressure from an aortic aneurysm in varying degrees. Consequently, a harsh, strident or hoarse voice as an early symptom of such a lesion brings the patient to the attention of the laryngologist, who readily recognizes the mediastinal significance of the paretic left cord. One may then complete the diagnosis by looking for a tracheal tug, abnormal surface pulsation near the sternum and roentgenographic and fluoroscopic evidence of increased aortic width.

Other causes of paralysis of the vocal cord are well known. Pressure exerted by enlargement of the thyroid gland, diseased lymph nodes, mediastinal growths, pleurisy, tumors of the esophagus, mitral stenosis or apical infiltration is not infrequently the cause of paresis of a vocal cord. Surgical injury, as in thyroidectomy, has too often resulted in permanent damage to the inferior laryngeal nerves. In some cases a form of toxic neuritis, due to various toxic agents, such as lead, alcohol, arsenic or atropine, has been observed. However, I wish to emphasize here an important differential diagnosis—that of arthritis or perichondritis of the thyroarytenoid articulation, which not infrequently goes unnoticed during indirect laryngoscopy and which results in a wasteful search for a deeper pathologic condition to explain the partial or complete immobilization of the cord.

The subject of this paper is the idiopathic paralysis of a vocal cord. This form of paralysis is called idiopathic when the nerve per se is involved, uninfluenced by pressure from without. It is assumed that the involvement is a neuritis which affects all the fibers of the inferior laryngeal nerve, immobilizing the vocal cord in the medial position.

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between maximum abduction and adduction, the so-called cadaveric position. I saw 5 such cases with complete immobilization of the vocal cord, and, by coincidence, all on the right side.

The clinical records of the patients were surprisingly alike. The patient quite suddenly noted a change in the quality of the voice, accompanied with abnormally quick vocal fatigue. On examination, the characteristic cadaveric position of the cord was manifest despite the absence of any endolaryngeal lesion or pathologic condition of the neck or chest. But what was found in all these cases—and this sign has not been reported previously in the literature on the subject—was a slight pain which was produced on pressure between the trachea and the esophagus, that is, along the pathway of the inferior laryngeal nerve. This response to pressure by an inflamed nerve is, in my estimation, the pathognomonic sign of this disease.

Some interesting conclusions can be drawn from this clinical picture. The Semon-Rosenbach law states that slowly produced injury to the inferior laryngeal nerve will affect the abductor fibers primarily and the adductor fibers secondarily. Thus, for example, when a slowly developing aortic aneurysm starts to press on a recurrent laryngeal nerve, in the early stages the glottis closes normally but the left vocal cord abducts poorly. Later, when the adductor fibers are injured by the persistent and increasing pressure, adduction as well as abduction is impaired. Finally, with continued insult, the cord assumes the "cadaveric" fixed position midway between maximum abduction and adduction and is then considered totally paralyzed. Many explanations have been offered for the Semon phenomenon, the most probable being that the abductor fibers are weaker and respond more readily to abuse than the sturdier adductor fibers.

This clinical course has been observed regularly and accepted universally. The progressively developing paralysis has been noted innumerable times in cases of advancing pressure on the inferior laryngeal nerves. But in the present cases there was a characteristic difference in that the damage seemed to attack every fiber of the nerve simultaneously, abductors and adductors, producing a "cadaveric" cord from the very onset. Thus, Semon's law did not operate in the present cases of neuritis of the inferior laryngeal nerve, the condition resulting in "idiopathic" paralysis of the vocal cord. The prognosis was uniformly good. The patients recovered completely with no apparent deviation from normal of the movements of the cord.

A perusal of the literature discloses several reports of idiopathic paralysis of the vocal cord. Ellis and associates,¹ explained the lesion

¹ Ellis, M., Critchley, M., and Davis, E. D. D. Discussion on Idiopathic Recurrent Laryngeal Nerve Palsies, *Proc Roy Soc Med* **39** 364 (May) 1946, *J Laryng & Otol* **61** 286 (May) 1946.

on the basis of glandular dyscrasia and allergy, Goldsmith² reported a case of paralysis of the posterior cricoarytenoid muscle on a toxic basis following the administration of tetanus antitoxin, other writers³ have noted paralysis following serum reactions, vitamin deficiencies (beriberi) or lead poisoning. In the discussion following the lecture of Ellis, Critchley and Davis on this subject at the Royal Society of Medicine, in London, Layton⁴ reported a case of a paretic vocal cord in which the diagnosis had been "idiopathic paralysis," whereupon he had assumed that the vocal cord did not move because of ankylosis of the correlated cricoarytenoid articulation. Layton failed to describe the complete clinical picture of his case, but he erred if he intended to convey the impression that all idiopathic paralyses are the result of an ankylosed joint.

As mentioned previously, the immobilized cord in cricoarytenoid arthritis or perichondritis may readily be diagnosed by endolaryngeal inspection after one or several careful studies. This type of pathologic process differs completely from that of "idiopathic paralysis." If there is no difference between the right and the left cricoarytenoid area, the joint is not affected and the lesion lies definitely in the substance of the inferior laryngeal nerve. Finally, Layton offered a grave prognosis in these cases of paralysis on the mistaken premise that pathologic changes in the cricoarytenoid joint were responsible. It is known that the outlook is quite favorable in true cases of idiopathic paralysis.

I was frankly puzzled by the coincidence that in all 5 cases of idiopathic paralysis of the vocal cord the right cord was affected, and I can only offer some possibly explanatory observations (apart from that of the left laryngeal nerve's being better covered by the surrounding tissues). One patient presented lateral pharyngitis, decidedly more acute on the right side and accompanied with catarrh of the right eustachian tube, which may have indicated neuritis by propinquity of the right inferior laryngeal nerve. Another patient exhibited a pronounced difference in the degree of laryngotracheitis, the paresis of the right vocal cord coinciding with the far greater inflammation of the right side of the larynx and trachea. Incidentally, this patient had periostitis of the right side of the mandible shortly after the paretic right cord resumed normal function. A third patient, a dentist, who

2 Goldsmith, P. G. A Consideration of the Medical and Surgical Problems Involved in Lesions Affecting the Recurrent Laryngeal Nerve, *Tr. Am. Laryng., Rhin. & Otol. Soc.* 50: 123, 1946.

3 Alcantara, V. C., and de Ocampo, G. The Larynx in Infantile Beriberi, *Arch. Otolaryng.* 30: 389 (Sept.) 1939.

4 Layton, T. B., in discussion on Ellis, Critchley and Davis.¹

was acutely allergic to procaine, had two attacks of idiopathic paralysis several years apart. In his case local care was supplemented by the use of antihistaminic drugs.

The history of the fourth patient is especially interesting. This man came under my observation after thorough examination at a laryngologic hospital, where he underwent many investigative procedures and was warned about the probability of an esophageal growth. My examination, including endoscopic and roentgenographic studies, indicated nothing pathologic. The patient responded rather promptly, within several weeks, to antineuritic medication combined with faradic stimulation, which was used in all the cases.

I have used the faradic method with much satisfaction. External electrodes are placed along the course of the recurrent laryngeal nerve, that is, in the zone between the pathways of the esophagus and trachea, internal electrodes are placed in the endolarynx. This is the method of choice, one which has afforded me palpable evidence of its efficacy as repeated laryngeal inspection indicated progressive improvement of the movements of the cords until complete cure was achieved. At the beginning improvement was very slow, but after a number of treatments a slight twitch of the cord indicated a definite turn for the better. The course of improvement was especially noticeable when I added the endolaryngeal electrodes to my equipment for faradic stimulation.

The fifth patient, the wife of a physician, came to me with total idiopathic paralysis of the right vocal cord. Her case was complicated by personal anxieties and shocks, which contributed to repeated relapses after satisfactory responses to the faradic treatment. At that, she responded remarkably to endolaryngeal treatment and obtained a strong voice after daily treatments. When she was discharged, the right cord moved normally in complete symmetry with the movements of the unaffected left cord.

In conclusion, the purpose of this paper is to focus the attention of the laryngologist on the occasional presence of "idiopathic paralysees" of the vocal cords. When both cricoarytenoid areas are normal, and when investigations of the neck and chest fail to explain a "cadaveric" cord, the laryngologist would do well to look for the pathognomonic tenderness on pressure deep in the neck in the area between the trachea and the esophagus. This sign alone will clarify the diagnosis and eliminate wasteful investigations. Fortunately, too, patients with this condition will respond to persistent treatment.

101 East Seventy-Fourth Street

HYDROGEN ION CONCENTRATION OF NASAL SECRETION IN SITU IN NEWBORN INFANTS

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AND

M A PERLSTEIN, M D

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IN PREVIOUS communications¹ we reported that (1) the p_H of nasal secretion in situ in clinically normal nasal passages of infants and children was found to range within the levels of 5.0 to 6.7, indicating a slightly acid state of secretion, and that (2) during the act of crying and hyperventilating the establishment of an alkaline nasal p_H was a dominant finding in infants and very young children.

In the present investigation, an unusual opportunity to study the p_H of nasal secretion in situ in a group of 13 newborn infants, ranging from 2 to 8 days in age, was provided by the nursery of a metropolitan hospital. The subjects were 7 male and 6 female infants. Although all 13 newborn infants had normal intranasal structures, 1 of the group had cerebral edema and another an occipital encephalocele. All the children were born by the vaginal route of healthy mothers, except for 1, who was delivered by cesarean section of an eclamptic mother.

The technical aspects of the determination of the p_H of the nasal secretions in the newborn infants were carried out under aseptic conditions by the adult participants—physicians, nurses and a technician. A specially constructed silver-silver chloride glass electrode, designed for study of the nasal reaction in newborn infants and produced according to specifications furnished to the manufacturer, was employed in conjunction with the Coleman electrometer. Because of the inherent difficulty of undertaking p_H readings on the nasal secretions of newborn infants over prolonged periods of time, three consecutive readings were taken at one-half minute intervals.

1 Fabricant, N. D., and Perlstein, M. A. Hydrogen Ion Concentration of Nasal Secretion in Situ in Infants and in Children, with a Comment on p_H Values in Pediatric Nasal Medication, *Arch Otolaryng* **47**: 765 (June) 1948, p_H of Nasal Secretion in Situ in Infants and in Children. Effect of Hyperventilation and Crying, *ibid* **48**: 67 (July) 1948.

Of the 13 subjects under study, all but 1 newborn infant engaged in the act of crying and hyperventilating (table) The p_H of nasal

Data on p_H of Nasal Secretion in Situ for 13 Newborn Infants

Patients	Age, Days	Sex	Weight at Birth	p_H of Nasal Secretion	Comment
1	8	F	6 lb 10 oz	6 00 6 25 6 10	
2	4	M	9½ lb	7 0 7 2 7 1	While crying, hyperventilating
3	6	M	6 lb 14½ oz	7 1 7 0 7 0	While crying, hyperventilating
4 (with cerebral edema)	2	M	7 lb 13 oz	7 1 7 0 7 1	While crying, hyperventilating
5	2	M	6 lb 15½ oz	6 8 7 1 7 2	While crying, hyperventilating
6	7	F	6 lb 7 oz	6 7 6 7 6 9	While crying, hyperventilating
7	6	F	7 lb 13½ oz	7 1 6 9 7 2	While crying, hyperventilating
8 (with occipital encephalocele)	6	F	8 lb 3 oz	7 2 7 2 7 2	While crying, hyperventilating
9	5	F	7 lb 2 oz	7 0 6 9 6 9	While crying, hyperventilating
10 (born by cesarean section, mother eclamptic)	5	M	7 lb	6 9 6 7 6 8	While crying, hyperventilating
11	5	F	7 lb ½ oz	6 9 6 8 6 7	While crying, hyperventilating
12	7	M	10 lb	7 0 6 8 7 0	While crying, hyperventilating
13	6	M	8 lb	6 7 6 8 7 0	While crying, hyperventilating

secretion in situ for this single noncrying exception was found to range from 6 00 to 6 25 For the 12 newborn infants who cried the p_H of the nasal secretion was found to range from 6 7 to 7 2

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OSTEOMA OF THE FRONTAL SINUS

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IT IS not the purpose of this paper to present a comprehensive report on osteoma of the frontal sinuses, as most of the facts now known about this condition can readily be found in such excellent recent articles as those of Teed¹ and Dowling². We also direct attention to the article by Handousa³ because of its many clearcut illustrations, roentgenograms and succinct case reports. The article by Cushing,⁴ although dealing primarily with orbitoethmoidal osteomas and their complications, had considerable influence on the subsequent surgical approach to osteomas of the frontal sinuses with intracranial complications. Conley's⁵ paper is of interest because it was the first to call attention to the repair of cranial defects by tantalum implants following surgical removal of osteomas of the frontal sinus.

An estimation of the relative frequency of osteoma of the frontal sinus might be deduced from the number of cases reported by different authors (table), or from the number of articles appearing in the medical literature on this subject. While osteoma of the frontal sinus appears to be more frequently encountered now than formerly, still, so far as the individual practitioner is concerned, it must be considered uncommon. For the surgeon who is to perform the operation in his own case the condition becomes rare, for a considerable number of the patients seen require no surgical intervention.

From the Eye, Ear, Nose and Throat Section, Fitzsimons General Hospital, Denver

1 Teed, W R Primary Osteoma of the Frontal Sinus, Arch Otolaryng 33 255-292 (Feb) 1941

2 Dowling, J R Osteoma of the Frontal Sinus, Arch Otolaryng 41 99-108 (Feb) 1945

3 Handousa, A S Nasal Osteomata, J Laryng & Otol 55 197-211 (April) 1940

4 Cushing, H Experiences with Orbital Ethmoidal Osteomata Having Intracranial Complications, with Report of Four Cases, Surg, Gynec & Obst 44 721-742 (June) 1927

5 Conley, J J Removal of a Frontal Osteoma and Correction of the Defect with a Tantalum Implant, Arch Otolaryng 40 295-298 (Oct) 1944

In 1941 Teed¹ collected 321 cases from the literature. His bibliography covers the references and citations, and of these, approximately one third of the originals were recorded in English. Since 1941 we have found 20 articles in the literature dealing exclusively with this subject, of which 10 are in English. Teed¹ stated that it was nearly one hundred and fifty years from the time of the recording of the first case of osteoma in the medical literature, by Veiga in 1586, until the next case was recorded, by Vallisneri in 1733. From 1926 through 1935 there was an average of more than one author per year who not only reported 1 or more cases but made an attempt to collect or estimate the total number of cases that had been reported in the

Frequency of Occurrence of Osteoma of Frontal Sinus

Author	Institution	No of Cases in Series	Period of Investigation	No of Cases of Osteoma
Andrews ²⁵	New York Eye and Ear Infirmary, New York Ophthalmological and Aural Institute and Manhattan Eye, Ear and Throat Hospital	429,000	Up to 1887	3
Faulkner ²⁵	Manhattan Eye, Ear and Throat Hospital	?	1904-1924	3
Teed ¹	St. Josephs Mercy Hospital, Ann Arbor, Mich.	48,000	1918-1939	2
Handousa ³	Kasr El Ain Hospital, Cairo, Egypt	840,000	1933-1940	13
Childrey ⁸	San Francisco Practice	Patients given roentgenograms of sinuses 3,510	1939	10
Dowling ²	United States Army General Hospital	Ear, nose and throat patients 7,129	1942-1945	5

literature up to the time of his own article. In spite of the frequent reports, no author had reported as many as 4 of his own cases until Carmody⁶ did so in 1935. It would seem that Carmody's⁶ article may be taken as a point of departure in the literature, for since its appearance there have been reported 30 cases by Sattler⁷ (1938), 9 cases by Childrey⁸ (1939), 13 cases by Handousa³ (1940) and 5 cases by Dowling² (1945). The cases reported by Sattler⁷ and Childrey⁸ were based on reviews of roentgenologic films, and those by Handousa³ were collected from reviews of hospital records.

⁶ Carmody, T. E. Osteoma of the Nasal Accessory Sinuses, *Ann. Otol., Rhin. & Laryng.* **44**: 626-643 (Sept.) 1935.

⁷ Sattler, A. Osteome der Stirnhöhlen, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* **43**: 464-479, 1938.

⁸ Childrey, J. H. Osteoma of the Sinuses, the Frontal and the Sphenoid Bone. Report of Fifteen Cases, *Arch. Otolaryng.* **30**: 63-72 (July) 1939.

We believe that many of the smaller osteomas are not reported. We have seen 6 cases of osteoma of the frontal sinus at this hospital in the past six months while on the eye, ear, nose and throat service. Of these 6 osteomas, 3 were small and asymptomatic. Two of the patients with the smaller osteomas were told to report back in eight months. The patient with the smallest osteoma, which was about 1 cm in diameter, was under treatment for bilateral chronic suppurative maxillary sinusitis. We had roentgenograms of the sinuses of this patient over a period of sixteen years, and during that time the osteoma had shown no variation in size or shape. No further comment will be made on the cases of the 3 smaller osteomas, but we shall report the others later. We shall also report a case in which operation had been performed for osteoma of the left frontal sinus at another institution nine years previously and in which we operated for obstruction of the left nasofrontal duct. The last case is interesting from the standpoint of the late results which may follow removal of osteoma of the frontal sinus.

The cause of osteoma is unknown, but of the various theories advanced, that of a new growth from an embryonal periosteal rest would appear to us to be the most acceptable. The number of cases associated with trauma has been sufficiently large that many authors have concluded that trauma may at least be a factor in stimulating rapidity of growth. Whether suppuration is significant in initiating or stimulating the growth is an unanswered question, but a fair percentage of osteomas are associated with suppuration. It is not known whether the purulent discharge is a primary, secondary or incidental factor.

The relative frequency of occurrence of osteomas as compared with that of other benign tumors of the nose and paranasal sinuses was given by Eggston and Wolff⁹ as 50 per cent of the total. This is a higher estimate than that given by most authors. It is not uncommon for the frontal and ethmoid sinuses to be involved with the same osteoma concurrently. Ersner and Saltzman¹⁰ reported a case with simultaneous involvement of all the sinuses and cited Pfeiffer and Weingarten as each having reported a similar case. The patient of Ersner and Saltzman¹⁰ had an osteoma involving the right frontal sinus, the ethmoid labyrinth, the sphenoid sinus and the right maxillary sinus, the tumor weighed 70 Gm. Hanley¹¹ reported three sep-

9 Eggston, A. A., and Wolff, D. *Histopathology of the Ear, Nose and Throat*, Baltimore, Williams & Wilkins Company, 1947, p. 750.

10 Ersner, M. S., and Saltzman, M. *Osteoma of the Sinuses*, *Laryngoscope* 48: 29-37 (Jan.) 1938.

11 Hanley, J. S. *Unusual Case of Osteoma of the Nasal Accessory Sinuses*, *Laryngoscope* 54: 235-237 (May) 1944.

arate osteomas occurring at the same time in their patient, one being in each frontal sinus and one in the ethmoid sinus

The frequency of complications in the 321 cases collected by Teed¹ was roughly as follows mucocoele, 12 per cent, pyocoele, 10 per cent, brain abscess, 3 per cent, and pneumatocele, 2.5 per cent. In 1 case meningitis was a complication, and in 1 cerebrospinal rhinorrhea. A few cases have been reported in which the osteoma grew back and deeply invaded the brain substance. Campbell and Gottschalk¹² reported such a case in which a mucocoele had extended into the lateral ventricle.

The relative frequency of occurrence of osteoma of the frontal sinus in comparison with osteoma of the other paranasal sinuses in the 458 cases collected by Malan¹³ is as follows: frontal sinus, 39 per cent, ethmoid sinus, 24 per cent, maxillary sinus, 9 per cent, sphenoid sinus, 2 per cent, nasal cavity, 5 per cent, origin doubtful, 7 per cent, and first cavity involved uncertain, 6 per cent.

The ages were recorded in 250 cases and the sex in 265 of the 321 cases collected by Teed¹. The distribution according to age was as follows: first decade, 0, second decade, 25 per cent, third decade, 37 per cent, fourth decade, 17 per cent, fifth decade, 10 per cent, sixth decade, 7 per cent, seventh decade, 3 per cent, and eighth decade, 0.4 per cent. The distribution according to sex was 65 per cent for males and 35 per cent for females.

Perhaps the most frequent site of attachment of the tumor is in the region of the junction of the ethmoid bones and the frontal sinus, although almost every area in the frontal sinus has been reported as the site of attachment. A few of the reported sites are the posterior plate, reported by Coates and Kraus¹⁴, the roof of the sinus, by Lang and Armour¹⁵, the upper lateral wall, by Goodyear¹⁶, the interfrontal septum, by Teed¹, the extreme upper part of the frontal plate,

12 Campbell, E. H., and Gottschalk, R. B. Osteoma of Frontal Sinus and Penetration of Lateral Ventricle, with Intermittent Pneumocephalus, *J. A. M. A.* **111** 239-241 (July 16) 1938.

13 Malan, E. Chirurgia degli osteomi delle cavità pneumatiche perifacciali (contributo anatomo-clinico), *Arch. ital. di chir.* **48** 1-124 (Jan.) 1938.

14 Coates, G. M., and Kraus, F. Osteoma of Frontal Sinus, *Ann. Otol., Rhin. & Laryng.* **50** 450-457 (June) 1941.

15 Lang, W., and Armour, D. Ivory Exostosis, Growing from the Roof of the Frontal Sinus into the Orbital and Cranial Cavities, Removed Through an Osteoplastic Opening in the Cranium by Mr. Donald Armour, *Proc. Roy. Soc. Med. (Sect. Ophth.)* **12** 16-19, 1919.

16 Goodyear, H. M. Osteoma of the Frontal Sinus Extending into the Orbit and Anterior Cerebral Fossa, *Laryngoscope* **35** 751-753 (Oct.) 1925.

by Johnson¹⁷, the upper mesial corner of the frontal plate, by Proetz¹⁸, the inferior mesial portion of the frontal plate, by Conley⁵, the floor external to the nasofrontal duct, by Hastings¹⁹, the floor involving both nasofrontal ducts, by Hanléy¹¹, the nasal spine, by Handousa³ and the infundibulum, by Barnhill²⁰. It is not uncommon for the surgeon to be unable to identify the site of attachment, owing to the extension and overgrowth of the tumor. A few cases have been reported in which the osteoma became detached and was extruded, usually through the orbit, remained in situ or became a loose body in the sinus. Jeschek²¹ reported an osteoma that dropped out of the nose.

The size and rate of growth vary considerably, but in general it can be said that the tumor is slow growing and that the rate of growth is usually faster in persons of the young age group. Thomas'²² patient had the tumor removed, and nine months later the growth was larger than it had been at the time of the operation. Osteomas at times tend to recur after removal, and a case was reported in which the tumor was removed ten times, each time with recurrence. Some osteomas have been followed for years with little or no appreciable change in size. Dowling² reported an osteoma the size of a pea, Conley,⁵ one the size of a goose egg, and Hagaman,²³ one the size of a baseball. Hoover and Horrax²⁴ stated that osteomas of the frontal sinus weighing 1 pound (453 Gm) have been described.

The symptoms, diagnosis and pathology of this condition will not be considered here, as discussions of these aspects are readily available in most articles on this tumor.

The physician, we believe, is more interested in the experience of others in the surgical treatment, since this is the only method of therapy,

17 Johnson, W. H. Osteoma of the Frontal Sinus, *Arch Otolaryng* **38** 318-323 (Oct) 1943

18 Proetz, A. W. Evaluation of the Displacement Method, with a Review of the Literature, *Ann Otol, Rhin & Laryng* **46** 699-734 (Sept) 1937

19 Hastings, H. An Osteoma of the Frontal Sinus, *Ann Surg* **41** 624 (April) 1905

20 Barnhill, J. F. Report of a Case of Large Osteoma Involving the Right Frontal Sinus and Uncovering the Adjacent Brain, *Ann Otol, Rhin & Laryng* **27** 1115-1117 (Dec) 1918

21 Jeschek, J. Ueber das Verhalten der Stirnhöhle beim Osteom, *Monatsschr f Ohrenh* **68** 1107-1111 (Sept) 1934

22 Thomas, G. F. Report of a Case of Osteoma of the Frontal Sinuses, *Am J Roentgenol* **5** 341-343 (July) 1918

23 Hagaman, V. Osteoma of Frontal Sinus, *Mississippi Doctor* **20** 209-211 (Oct) 1942

24 Hoover, W. B., and Horrax, G. Osteomas of the Nasal Accessory Sinuses with Report of a Case Illustrating the Trans-Cranial Approach to Orbital Structures, *Surg, Gynec & Obst* **61** 821-826 (Dec) 1935

than he is in other phases of osteoma. Unfortunately, surgical treatment is probably the topic least discussed in most papers. As osteomas vary greatly in their attachments, position, size, configuration, bony consistency and secondary complications, such a discussion would be most useful. Carmody⁶ probably had this in mind when he wrote, "Since no one operator has had a sufficiently large number of cases to evaluate various methods of surgical procedure, the method must depend on the particular case."

Since Cushing's⁴ article in 1927, there seems to have been general agreement that in the removal of those tumors in which a dural tear is likely to result the best approach is from the dural side. Cushing⁴ was not the first to use this approach, for it had been used in 1918 by Lang and Armour¹⁵. Cushing,⁴ however, was the first to use a strip of fascia lata to cover the tear in the dura, and his article greatly popularized the intracranial approach. Conley⁵ repaired the torn dura by covering it with a segment of the frontalis muscle. Coates and Kraus¹⁴ used bone chips over the dura to act as a nidus for bony repair of the posterior plate of the frontal sinus.

The incision used should be such as to give adequate exposure for removal of the tumor and to leave as little postoperative deformity as possible. Although many different approaches have been used, the most frequent has been a curvilinear incision above, below or through the eyebrow, with and without extensions along the corresponding side of the nose, as generally used in the external radical frontoethmoidal sinusotomy. In figure 1 we have sketched some of the other approaches used by different surgeons. Incisions *A* and *B* can be used for the intracranial approach. Incision *C*, with the long vertical extension, was used for insertion of a vitallium[®] plate to repair postoperative deformity. Incisions *C*, *D* and *E* should give adequate exposure, when indicated, for either an osteoperiosteal flap or insertion of a metal plate to repair postoperative defects. Incision *E*, when it could be used, would probably result in less visible scarring.

The tumor has usually been attacked by chiseling to free, or partially free, it from its attachment and then rocking it loose with large rongeur forceps. Hoover and Horrax²⁴ used a bone drill to free the osteoma partially. If the tumor is cancellous at its attachment, a curet is useful to clean up the residual bone after the main part has been removed.

There has been a difference of opinion as to the method of dealing with the nasofrontal duct and with the mucosal lining of the sinus. Johnson¹⁷ stated that one should not remove the lining of the sinus if it is not infected. He left a fenestrated no. 12 catheter in the nasofrontal duct to promote drainage of the sinus and to prevent infection.

of the sinus from the nose. Conley,⁵ in order to prevent infection of the sinus from the nose, plugged a strip of frontalis muscle into the nasofrontal duct and by electrodesiccation fixed it to the surrounding tissue. Coates and Kraus¹⁴ packed the nasofrontal duct. Dowling² stated that the duct should be left alone. Regardless of the internal management of the sinus, many surgeons have left a drain in the dependent part of the sinus to drain it externally.

Dowling² has given a good preoperative regimen. He used sulfonamide drugs before and after operation. Streptomycin and penicillin are now available when indicated.

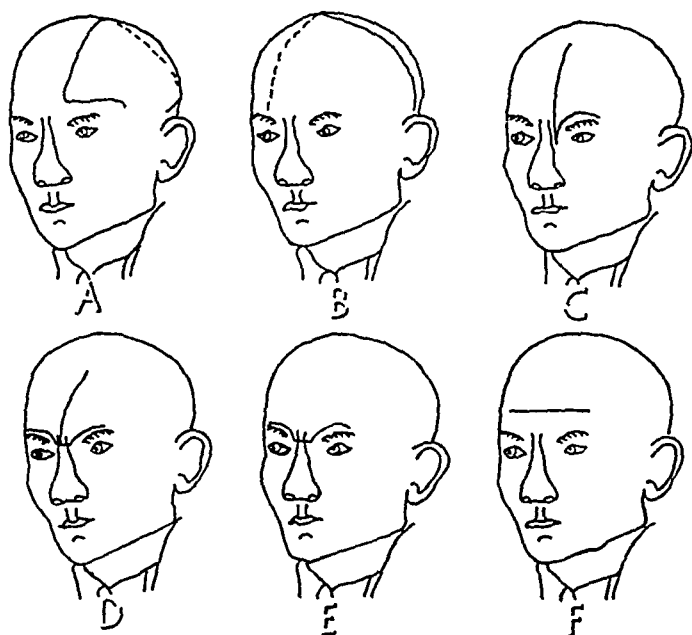


Fig 1—Incisions used by various authors in approach to osteoma of the frontal sinus. *A*, horseshoe temporal flap, Cushing⁴, *B*, transcranial post-hair-line flap, Hoover and Horrax²⁴, *C*, curvilinear eyebrow-nasal incision with vertical extension, Conley⁵, *D*, eyebrow butterfly incision with vertical extension, Hagaman²³, *E*, eyebrow butterfly incision, Hanley¹¹, *F*, horizontal transfrontal incision, Dowling². Note that the part of the incision shown above the eyebrow in *C*, *D* and *E* would ordinarily be made through the eyebrow to reduce visibility of the scar.

The operative mortality rate has been estimated by various authors as follows. Berlin,²⁵ in the preaseptic period, prior to 1880, as 25 per cent, Teed,¹ in the aseptic period, from 1875 to 1941, as 3.7 per cent, and Dowling,² in the period of biologicals, as less than 1 per cent. Teed¹ listed the causes of the postoperative deaths that occurred in 7 of 189 operative cases in the period from 1875 to 1941. The most frequent cause of death was meningitis.

25 Cited by Teed¹

REPORT OF CASES

CASE 1—The patient, aged 22, a soldier of Latin-American descent, had lived all his life in Colorado. He had worked as a carpenter before joining the Army, four and one-half years prior to admission. He had never been in the tropics. He used no alcohol and smoked moderately. His previous personal history and family history were not significant. There was no history of trauma.

He was admitted to this hospital on May 11, 1948, with the complaint of having had a head cold for a week and a steady headache in the left frontal area for the previous forty-eight hours. He stated that he had not previously been treated for any trouble of the ears, nose or throat and had never experienced any pain

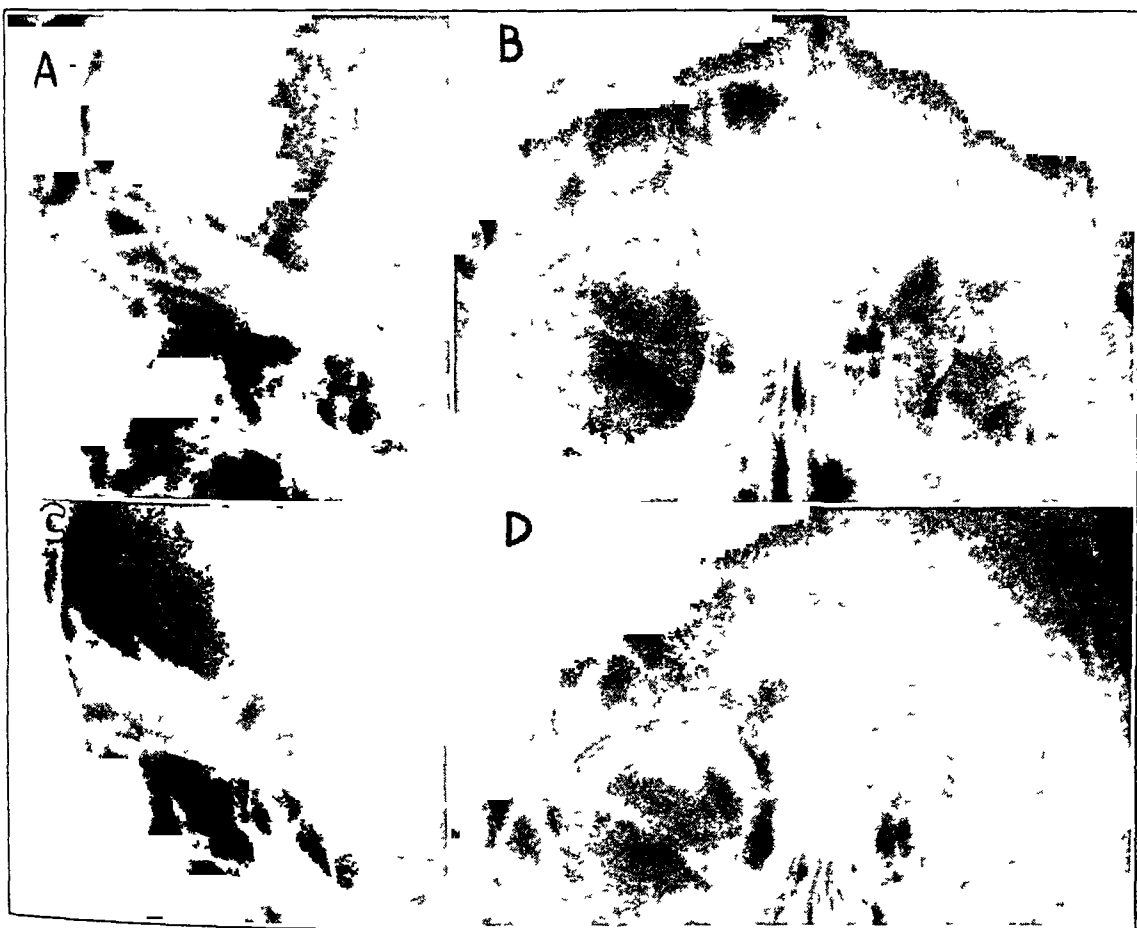


Fig 2 (case 1)—*A* and *B*, lateral and anteroposterior roentgenograms taken prior to operation. A well demarcated area of increased density is present in the midline of the frontal sinuses. *C* and *D* lateral and anteroposterior roentgenograms taken after operation.

or tenderness in the sinusal regions, or had prolonged headaches or any unusual amount of nasal or postnasal discharge. Examination of the sinuses in the eye, ear, nose and throat clinic showed moderate wet turgescence of the nasal turbinate bodies on both sides and pus under the left middle turbinate body. Transillumination showed darkening over the frontal area, so that an emergency roentgenogram of the sinuses was ordered.

The roentgenogram showed a well demarcated area of increased density in the midline of the frontal sinuses with a lobulated appearance typical of an osteoma.

(fig 2 *A* and *B*) The mass measured 2.3 by 3.2 cm in the widest diameters. The lateral roentgenogram of the sinus showed pronounced thinning of the anterior plate of the sinuses, and the attachment of the osteoma appeared to be low on the posterior wall. The nasal accessory sinuses were otherwise normal in appearance.

Physical examination revealed an essentially normal condition except for the findings mentioned. The roentgenogram of the chest and the results of routine laboratory examinations, including serologic tests, were normal. Cultures of the pus under the left middle turbinate body were reported as showing *Staphylococcus aureus*, hemolytic streptococci and *Aerobacter aerogenes*.

The patient was placed on a regimen of therapy intended to clear up the suppuration prior to operation. The treatment consisted of vasoconstrictive nasal



Fig 3 (case 1) —Osteoma after removal (1) thinned-out anterior plate of the frontal sinus, (2) osteoma, from the frontal sinus, (3) portion of mucocoele, (4) posterior plate of left frontal sinus

tampons, nasal suction and injections of 50,000 units of penicillin intramuscularly every four hours for two weeks. Both maxillary sinuses were irrigated with an aqueous solution of 2,000 units of penicillin per cubic centimeter early in the period of hospitalization as a diagnostic measure to rule out any suppuration of the maxillary sinus. This was done in spite of the normal transillumination and the roentgenographic findings. The washings from both maxillary sinuses were clear.

The operation was performed on June 1, with the patient under anesthesia produced by intravenous injection of thiopental sodium. The butterfly incision through the eyebrows, as illustrated in *E* of figure 1, was used for the exposure.

It was our intention to make an osteoperiosteal flap if this proved feasible, but the anterior plate of the sinuses over the tumor was of eggshell thinness, so that after the periosteum was elevated the thin anterior plate was chipped away. The osteoma was in the midline, having pushed the interfrontal septum into the lateral part of the right frontal sinus. The attachment, which was sessile and about 2 cm in diameter, ran from the region of the left nasofrontal duct up the posterior wall of the sinus for about 2.5 cm. A mucocoele was present in the lateral and superior portions of the left frontal sinus. The greater mass of the osteoma was removed by chiseling around its attachment until it could be rocked free (fig 3). Piecemeal excision of the residual attachment was accomplished by chisel and curets. The interfrontal septum was removed with the osteoma (fig 2C and D). The nasofrontal duct was left alone. The sinus was not obliterated, but the overhanging walls were smoothed. Closure was effected with black silk sutures, and a small rubber catheter was sutured into the lower part of the incision on the left side. The sinus was irrigated daily with an aqueous solution of penicillin, 2,000 units



Fig 4 (case 1)—Postoperative appearance of the patient

per cubic centimeter, for five days. Postoperative recovery was uneventful and the patient was asymptomatic. Two weeks after the operation he requested and was granted a furlough. He had only a moderate amount of noticeable deformity (fig 4).

CASE 2—The patient, an 18 year old white youth, reported to the eye, ear, nose and throat clinic on July 6, 1948, with the complaint of frontal headaches for the previous six months, which were present on waking in the morning and were usually gone by noon. He stated that the headaches appeared to make his vision "blurry." He also complained of stuffiness of the nose. Examination revealed nothing pathologic except for moderate deviation of the septum to the right. There was no nasal discharge. At this time a roentgenogram of the paranasal sinuses showed a smooth, rounded osteoma of the interfrontal septum, measuring about 2 cm at its greatest diameter, with the main mass projecting into the right frontal sinus (fig 5A and B). Because there was a possible rotary nystagmus on lateral gaze, neurologic consultation was requested, but no other significant neurologic

finding was noted. Results of the physical examination and of the laboratory work were not significant.

A submucous resection was done on July 21, and the postoperative course was uneventful. Because the persistent headaches were relieved only by constant use of tablets containing acetylsalicylic acid, acetophenetidin and codeine, it was thought advisable to remove the osteoma. This was done on August 12 (fig 5 C and D).



Fig 5 (case 2) — *A* and *B*, lateral and anteroposterior roentgenograms taken prior to operation, *C* and *D* lateral and anteroposterior roentgenograms taken after operation.

The operation was done with the patient under anesthesia produced by thiopental sodium, supplemented with nitrous oxide and oxygen. A horizontal frontal incision was made about 1 inch (2.5 cm) above the brow line and extending about 1 inch to either side of the midline. The periosteum was elevated, and into each frontal sinus a small hole was chiseled sufficiently laterally to be outside the border of the growth, which saddled the interfrontal septum. These holes were enlarged superiorly and inferiorly in a semicircular manner so as to outline the extent of the tumor. The septum both above and below the osteoma was chiseled through.

down to the posterior plate of the frontal bone. The interfrontal septum between the growth and the posterior plate was partially chiseled away. The osteoma was grasped with a large rongeur forceps and rocked loose from its base (fig 6). The remains of the broad sessile attachment, which was about 1.5 cm in width near the roof of the right frontal sinus, was curetted away. The sinus was packed with petrolatum gauze, one end of which was left protruding from the left extremity of the incision wound. The mucosal lining of the sinus and the naso-frontal ducts were not disturbed. The periosteum was closed with 0 surgical gut U S P, and the skin, with black silk sutures.

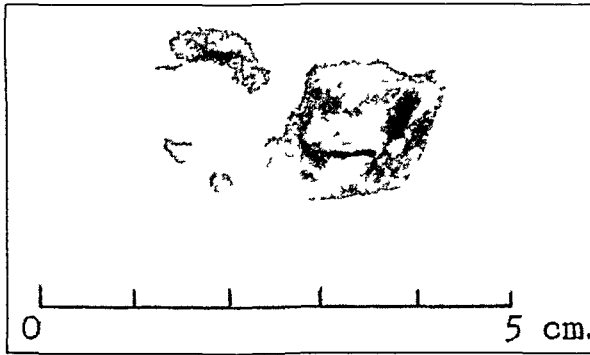


Fig 6 (case 2)—Osteoma after removal



Fig 7 (case 2)—Postoperative appearance of the patient

The postoperative recovery was uneventful. The patient was completely free from headaches and was discharged from the hospital approximately two weeks after the operation (fig 7).

CASE 3—The patient, a white soldier, aged 19, in 1946 had fallen on his face and fractured his nose. Since that time he had suffered from pain over the bridge of the nose and the left frontal sinus. A submucous resection was performed at a general hospital in the early part of 1947, but this did not relieve his symptoms. In June 1948 he was hospitalized one month because of pain over the left eye and a low grade fever. Treatment during this period consisted of nasal shrinkage and intramuscular administration of penicillin.

At the end of the last hospitalization, he was transferred to Fitzsimons General Hospital on July 26. Physical examination revealed an essentially normal condition except for impacted molar teeth. Roentgenograms showed a small osteoma, about 2 cm in diameter, in the left frontal sinus and attached to the roof of the left orbit (fig 8 *A* and *B*).

On August 27 the patient was given thiopental sodium (pentothal®) intravenously, and the osteoma was removed by external sinusotomy, the regular Killian incision being used. The tumor was attached to the roof of the left orbit by a broad base and to the posterior wall of the frontal sinus by a small pedicle. The patient was given penicillin intramuscularly for five days post-

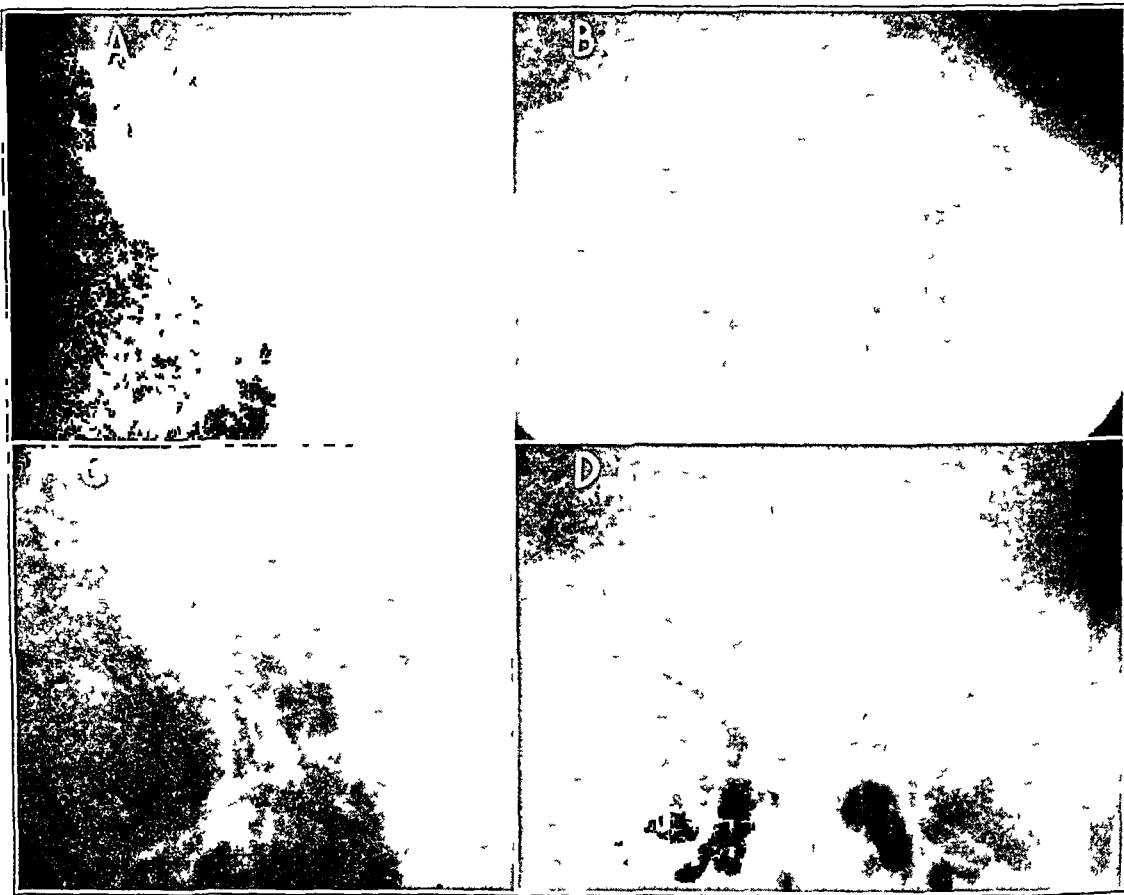


Fig 8 (case 3)—*A* and *B*, lateral and anteroposterior roentgenograms taken prior to operation, *C* and *D*, postoperative roentgenograms

operatively and made an uneventful recovery. One month after the operation he stated that he had had no recurrence of the symptoms. Figure 8 *C* and *D* show the postoperative roentgenograms. The tumor after removal and the patient two weeks after the operation are shown in figures 9 and 10.

CASE 4—We did not remove an osteoma in this case, but the patient had had such a growth removed from the left frontal sinus nine years previously, at a large, well known midwestern clinic. The history of the patient is interesting and instructive. He reported to the eye, ear, nose and throat clinic of Fitzsimons General Hospital on Aug 14, 1948, with pain, tenderness and edema over the left frontal sinus. The left eye was bulging markedly, the lids of the same eye were swollen

to complete closure, except that the edematous palpebral conjunctiva of the lower lid was protruding about 1 cm between them throughout the length of the lower lid. The periorbital tissues and the left side of the nose were inflamed, swollen and tender. No pus was seen in the nose. A scar from a previous Killian incision was visible in the left eyebrow. The eyegrounds were normal.

The history, obtained from both the patient and other clinics, was as follows: Sixteen years previously, in 1932, when the patient was 13 years old, he had fractured his nose in a boxing match. After this fracture he had an obstructed right nostril and pain over the left frontal sinus. In the following seven years he had had 7 intranasal operations, none of which had completely relieved the symptoms. The bridge of the nose had been depressed since the second operation.



Fig 9 (case 3)—Osteoma after removal

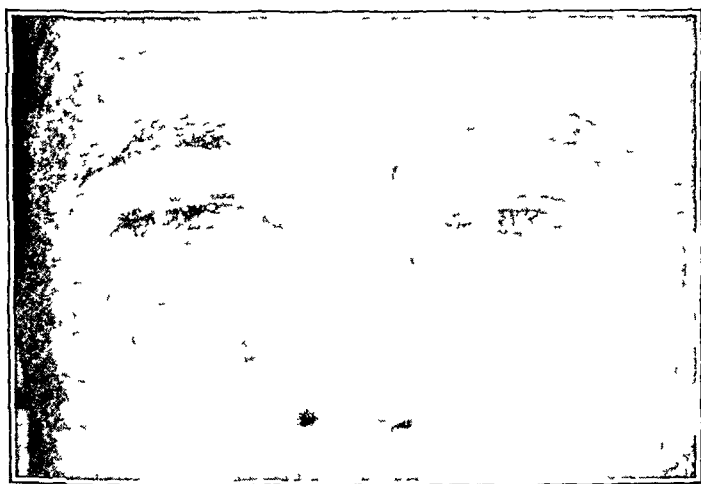


Fig 10 (case 3)—Appearance two weeks after operation

He reported to the previously mentioned clinic in October 1939. Examination at that clinic revealed his nose to be filled with purulent secretion on the right side. A small window was present in the right antrum. The anterior tip of the right middle turbinate body had been removed. A partial submucous resection had been performed, leaving the entire palatine portion, which was deviated to the right. Roentgenograms showed a thickened membrane throughout the frontal sinus and a small osteoma of the left frontoethmoidal region (fig 11A and B). The submucous resection was completed on October 10. Two days later the left frontal sinus was entered through the external approach. The floor of the sinus was removed, and a spongy osteoma measuring 1.5 by 1 by 1 cm, was taken from the region of the nasofrontal duct, where it had blocked the duct. The frontal sinus above the osteoma was filled with a degenerated polypoid membrane, which was

curetted lightly but which was not completely removed. Anterior ethmoid cells were removed to fashion a large nasofrontal duct. A rubber tube drain was placed in the frontal duct and the wound drained.

The patient returned to the same clinic in May 1940 with the nasofrontal duct closed by scar tissue. The scar tissue was removed and the patient discharged. He returned again in January 1941 with the same complaint, and the left nasofrontal duct was again found to be closed. Detailed studies for extensive allergy gave negative results. Histamine desensitization was attempted, but the patient

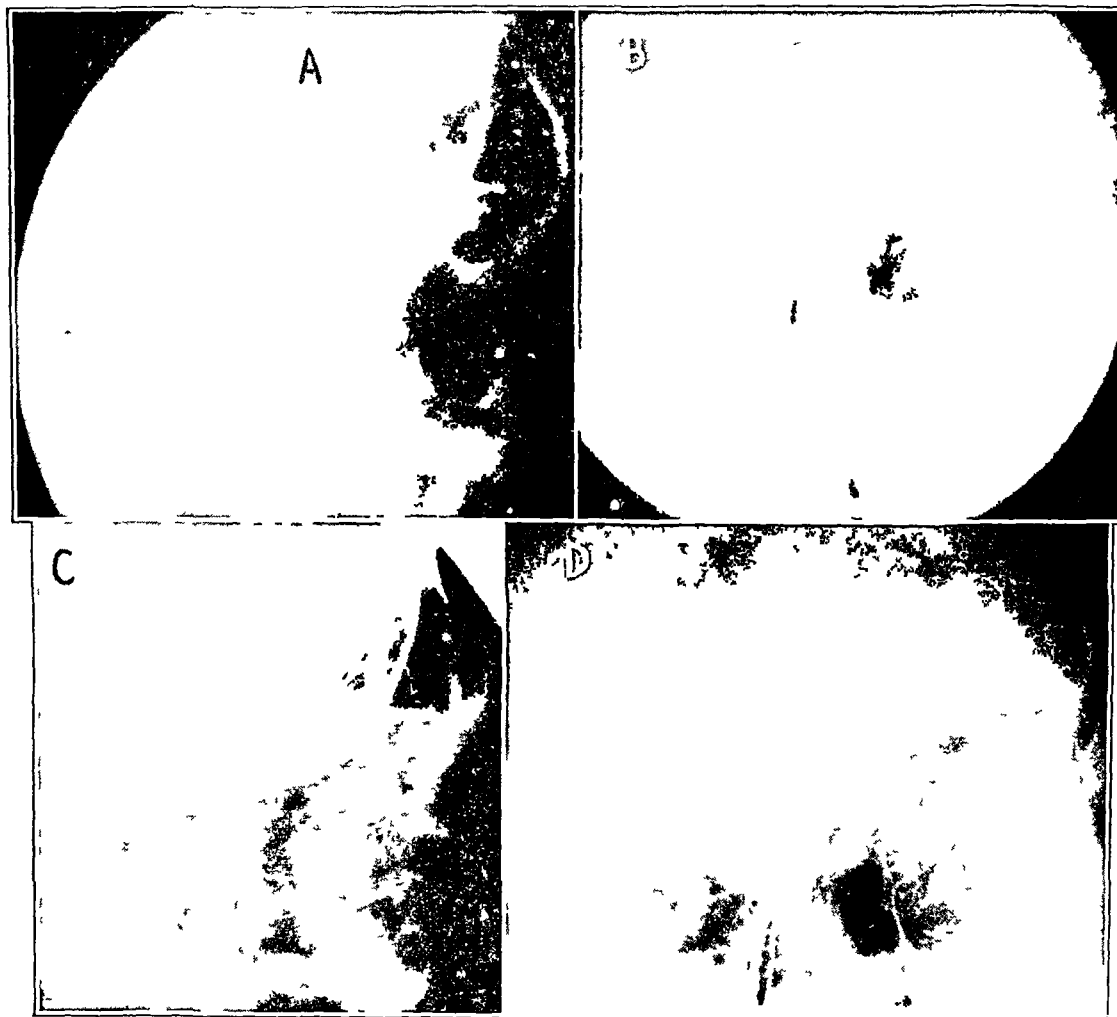


Fig 11 (case 4)—*A* and *B*, lateral and anteroposterior roentgenograms taken prior to operation for osteoma, *C* and *D*, lateral and anteroposterior roentgenograms taken prior to operation for obstructed nasofrontal duct in the same patient

did not remain long enough for treatment to be completed. In 1945 he returned to the clinic and had a rhinoplasty for the external nasal deformity.

In January 1948 he went to a well known, large eastern clinic because of a constant throbbing pain over the left eye and the left side of his head. The auriculotemporal nerve was divided at this clinic.

On May 5 he went to a hospital in the New England area with pain and swelling over the left eye. The upper lid was half closed and there were marked erythema and edema. Ocular muscle balance and visual fields were normal, and

there was no diplopia or conjunctivitis. The pupils reacted to light and in accommodation. The nasal mucosa of the left vestibule was greatly swollen, obstructing the airway in the region of the middle and inferior turbinate bodies. Physical examination showed an otherwise normal condition, and the laboratory studies were noncontributory. Roentgenograms showed pansinusitis, with absence of the roof of the left orbit as a result of previous operation. A radical operation was performed on the left frontal sinus, and a large mucocoele was removed. A tantalum screen was inserted in the nasofrontal duct to provide constant drainage. The patient was discharged on June 5.

Approximately nine weeks after his discharge from the New England hospital, he was admitted to Fitzsimons General Hospital, with findings as previously described. Roentgenograms showed cloudiness of the left frontal sinus and the coiled tantalum wire mesh in the left nasofrontal duct (fig 11 *C* and *D*). A diagnosis of suppurative inflammation of the left frontal sinus with secondary abscess in the left periorbital region was made. On August 18 a radical operation was performed on the left frontal sinus. There was pronounced hyperplasia of the sinus mucosa with granulation tissue. This was curetted out. The tantalum wire had acted as a scaffold across the nasofrontal duct, and its interstices were completely filled with granulation tissue. The wire and granulations were removed down into the left ethmoidal labyrinth. Pus was encountered in the periorbital tissue and in the posterolateral and anteromedial angles of the frontal sinus. A no. 16 French perforated catheter was left in the enlarged nasofrontal duct. The lids of the eye were sutured together to prevent erosion of the cornea and to afford protection to the protruding edematous conjunctiva. The patient was given intramuscular injections of penicillin and made an uneventful recovery. He was discharged from the hospital on September 18.

A NEW INTRALARYNGEAL APPROACH IN ARYTENOIDECTOMY IN BILATERAL ABDUCTOR PARALYSIS OF THE VOCAL CORDS

Report of Three Cases

WILLIAM C THORNELL, M D
CINCINNATI

VARIOUS surgical procedures have been devised for the correction of bilateral abductor paralysis of the vocal cords. In almost all cases so reported the paralysis resulted from operations on the thyroid gland. No attempt will be made here to review all the procedures to be found in the literature, but those most commonly employed will be mentioned.

Surgical treatment of bilateral abductor paralysis of the vocal cords gained renewed interest after the report of King¹ in 1939. Originally he conceived the idea of transposing the anterior belly of the omohyoid muscle to the arytenoid cartilage, with the idea of restoring the function of the paralyzed posterior cricoarytenoid muscle. The operation, described as a means of opening the cord by use of the transposed muscle, actually was a new method of displacement of the cord.

Hoover² had previously reported success with submucous resection of the vocal cord. Kelly³ described a procedure in which arytenoidectomy was carried out through a small window in the thyroid cartilage. Wright⁴ presented a modification of Kelly's procedure in which he suggested that the extreme posterior end of the vocal cord be sutured to the external perichondrium at the lower margin of the window so as to

From the Division of Otolaryngology, University of Cincinnati College of Medicine.

Presented with modifications before the Fifty-Third Annual Meeting of the American Academy of Ophthalmology and Otolaryngology, Chicago, Oct 13, 1948.

1 King, B T. A New and Function-Restoring Operation for Bilateral Cord Paralysis. Preliminary Report, *J A M A* **112** 814 (March 4) 1939.

2 Hoover, W B. Bilateral Abductor Paralysis. Operative Treatment by Submucous Resection of the Vocal Cords, *Arch Otolaryng* **15** 339 (March) 1932.

3 Kelly, J D. Surgical Treatment of Bilateral Paralysis of the Abductor Muscles of the Larynx, *Tr Am Acad Ophth* **45** 133, 1941.

4 Wright, E S. The Kelly Operation for Restoration of Laryngeal Function Following Bilateral Paralysis of the Vocal Cords. Report of Three Cases, *Ann Otol, Rhin & Laryng* **52** 346, 1943.

obtain a larger glottic opening posteriorly McCall and Gardiner⁵ also presented a modification of the Kelly procedure for a more simplified operation in treating bilateral abductor paralysis of the vocal cords

Orton⁶ described a lateral transthyroid approach (Trotter's) in which an arytenoidectomy was performed after removal of the posterior third of the ala of the thyroid cartilage The internal perichondrium and the thyroarytenoid muscle were then fixed to the external perichondrium and anterior portion of the split sternohyoid and thyrohyoid muscles

INTRALARYNGEAL APPROACH THROUGH SUSPENSION LARYNGOSCOPE⁷

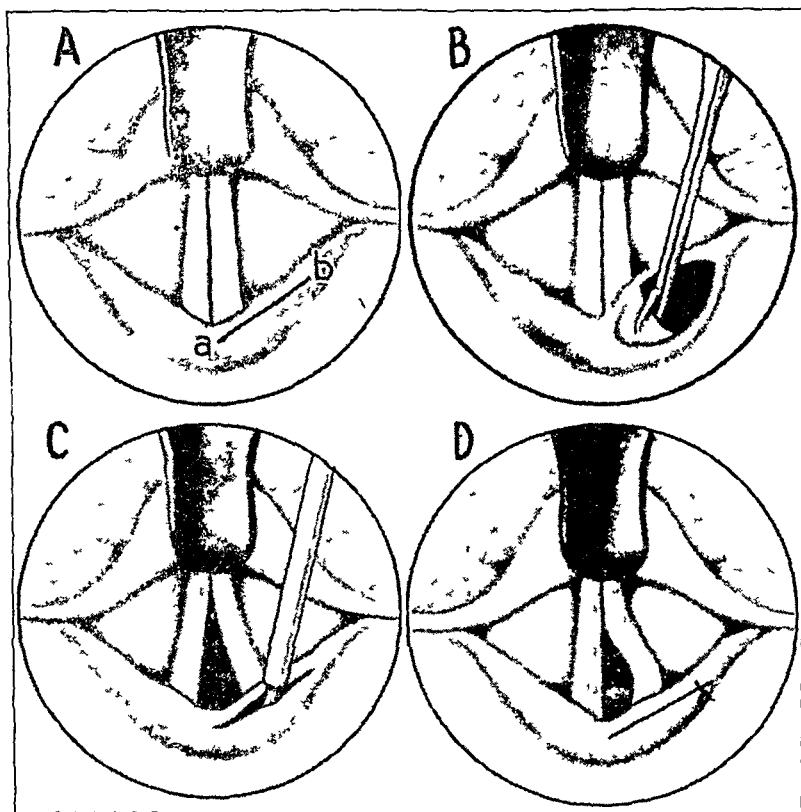
The patients selected in this instance for arytenoidectomy were those who had bilateral paralysis of the vocal cords as a result of operation on the thyroid The removal of the arytenoid cartilage by the intralaryngeal approach is carried out through the Lynch laryngeal suspension apparatus, with combined local application of cocaine and intravenous injection of thiopental sodium U S P (pentothal sodium®) The patient is hospitalized the day before operation Preoperative medication is determined by the individual case After the patient has been anesthetized, the suspension laryngoscope is placed in position, and further anesthesia is obtained with the local application of 5 per cent cocaine hydrochloride over the vocal cord and the aryepiglottic fold A continuous supply of oxygen is administered through the tracheal cannula during the operation An incision 1 cm in length is made over the superior surface of the arytenoid cartilage and extended anterolaterally into the aryepiglottic fold (figure, *A*) The superior border of the cartilage is identified and tightly held by a grasping forceps (figure, *B*) This is more easily done if the forceps has a lock handle Submucous dissection of the arytenoid cartilage is then carried out The various muscular attachments are separated from the cartilage on its lateral aspect The superior portion of the arytenoid cartilage is then rotated laterally so as to facilitate the separation of the muscular attachments on the medial aspect of the cartilage A very sharp laryngeal knife is used to carry out the previously mentioned dissection It is extremely important to avoid tearing or injuring the mucous membrane on the lateral wall of the larynx, since scarring in this area with a resulting cicatrix may nullify one's attempt to increase the glottic opening After complete removal of the arytenoid cartilage, a guarded curved electrocautery point is deeply inserted through the incision along the

⁵ McCall, J W, and Gardiner, F S A Simplified Operation for Bilateral Abductor Paralysis, *Laryngoscope* 53 307, 1943

⁶ Orton, H B Surgical Approach for Arytenoidectomy in Bilateral Abductor Paralysis of the Larynx, *Laryngoscope* 53 709, 1943

⁷ Thornell, W C Intra-Laryngeal Approach for Arytenoidectomy in Bilateral Abductor Paralysis of the Vocal Cords A Preliminary Report, *Arch Otolaryng* 47 505 (April) 1948

course of the thyroarytenoid muscle, beneath the vocal cord, and into the space previously occupied by the arytenoid cartilage (figure, C) Further lateral fixation of the posterior two thirds of the vocal cord is thus attempted by means of the contracture resulting from the electrocautery Bleeding throughout the course of the operation is at a minimum and is readily controlled with the electrocautery unit A chromic surgical gut suture was originally employed to close the anterior half of the incision, the posterior portion being allowed to remain open to afford drainage (figure, D) An acrylic obturator,



Schema showing (A) the incision *a-b* over the arytenoid area extending into the aryepiglottic fold, (B) position of the arytenoid cartilage, tightly held by a grasping forceps, (C) lateral displacement resulting from the removal of the arytenoid cartilage, with the guarded electrocautery point in position for cauterization, (D) lateral displacement of the posterior two thirds of the vocal cord, showing position of the suture at the anterolateral aspects of the incision

fashioned to be inserted between the cord, is anchored inferiorly to the flange of the tracheal cannula and superiorly to the outer surface of the cheek with adhesive tape This produces closer approximation of the edges of the wound and speeds primary healing Laryngeal edema is pronounced for the first three to four days The obturator is removed in three to seven days The edema is noted to subside by the tenth to the fourteenth day The cannula is removed twenty to thirty days after operation

REPORT OF THREE CASES

CASE 1⁷—A white woman aged 54 was seen in my office for the first time on Oct 12, 1945. She presented a history of a thyroidectomy in September 1944. Immediately after the operation respiratory distress developed and required a tracheotomy. Her symptoms improved, and in four weeks the tracheotomy tube was removed. In March 1945 complete laryngeal obstruction developed, requiring replacement of the tracheotomy tube, which she retained up to the time I saw her.

On laryngeal examination, both vocal cords were found to be fixed in the midline position. A tracheotomy tube was in place. When the tracheotomy tube opening was covered, air could not pass through the glottic opening on inspiration, and both cords remained in their midline position. The remainder of the examination of the ears, nose and throat disclosed nothing of significance.

On May 4, 1947 the patient entered the hospital, and the following day arytenoidectomy was carried out on the right side through the Lynch suspension apparatus with the patient under anesthesia produced by intravenous injection of thiopental sodium, as I have outlined. The slight bleeding encountered was completely controlled by the electrocautery unit. The patient received injections of penicillin during her postoperative course. Thoracic pain delayed the patient's dismissal from the hospital. Physical examination and roentgenograms of the chest at this time revealed nothing abnormal. On May 14 she was dismissed from the hospital.

The patient was allowed to use her voice after the third postoperative day. Laryngeal edema subsided in ten days. The tracheotomy tube was completely sealed after three weeks and remained so until it was removed on June 23. The resulting glottic opening, when viewed indirectly, was 3 mm posteriorly, the right vocal cord being retracted laterally.

On June 28 the patient was again hospitalized, and the tracheotomy opening was closed with use of local anesthesia. The patient was dismissed from the hospital on the following day. Her postoperative course was otherwise uneventful.

The patient has no difficulty with respiration at the time of this writing, and her voice is somewhat better than it was prior to operation. She has gained 25 pounds (11.3 Kg) in weight since the operation.

CASE 2—A white man aged 55 was first seen in my office on Dec 8, 1947. His chief complaint was a history of shortness of breath on exertion and noisy respirations. The shortness of breath on exertion was so extreme as to prevent him from doing any strenuous work. The respiratory crow on inspiration became pronounced on exertion and was especially noticeable during sleep. The patient's neighbors complained of difficulty in sleeping in the summertime when the windows were opened because of this loud inspiratory crow.

He stated that in 1935 a thyroidectomy had been carried out elsewhere and was immediately followed by hoarseness. No respiratory distress was evident at that time. Two years later shortness of breath on exertion and an inspiratory crow, accentuated by exertion, were noted. The patient was forced to resign from his job and to limit himself to light work as a result of the shortness of breath. On approximately ten occasions laryngeal obstruction, accompanying an acute infection of the upper respiratory tract, became so evident that a tracheotomy was considered, but the patient was able to recover under conservative measures and close observation. At the time of my examination, both vocal cords were found to be fixed in the midline position, with only a glottic opening of 1 mm. A low transverse cervical thyroidectomy scar was noted. The remainder of the

examination revealed an essentially normal condition. The possibilities of further enlarging this glottic opening and establishing a better airway were thoroughly discussed with the patient, and he decided to proceed with the operation.

On Jan 19, 1948 the patient entered the hospital, and the following day tracheotomy was carried out, with the use of local anesthesia. Immediately after this, arytenoidectomy was performed on the left side through the Lynch laryngeal suspension apparatus, as previously described. A modification of this procedure was carried out, in that placement of the suture at the anterior end of the incision was omitted and approximation of the edges of the mucous membrane was attempted by introducing a gold-plated O'Dwyer intubation tube into the glottis. The tube was not anchored inferiorly, and approximately six hours after operation the patient coughed it out. Penicillin was administered after operation. On the third postoperative day the patient had an acute infection of the upper respiratory tract, which prolonged his period of hospitalization to ten days. Laryngeal edema persisted ten days. The airway was found to be very adequate, and the tracheotomy tube was sealed over on the fourteenth day and removed on the eighteenth day. The patient had been instructed not to use his voice until the tracheotomy tube was sealed over. The resulting glottic opening, as viewed indirectly, was 4 mm posteriorly. The left vocal cord was retracted laterally.

At the time of this writing, the patient has a very good airway, and his voice has shown slight improvement. Shortness of breath on exertion and the inspiratory crow have completely disappeared. The patient's activity has been considerably increased. He is now doing more strenuous work and has gained 15 pounds (6.8 Kg) in weight.

CASE 3—A white woman aged 62 was first seen in my office on Feb 14, 1948. She stated that in 1923 a thyroidectomy had been performed, with immediate resulting hoarseness. In October 1946 a second thyroidectomy was carried out. This was followed by complete aphonia, lasting three months, and hoarseness was noted after that. Respiratory distress on exertion was not noted until the following year. An inspiratory crow, especially noticeable at night, followed the second thyroidectomy. Since September 1947 any exertion had produced marked increase in respiratory effort and an increase in the inspiratory crow. In January 1948 a change in the voice was noted, the patient describing the voice as being more normal. Increased difficulty with respiration and increase in the inspiratory crow also occurred. On Jan 22, 1948 a tracheotomy was performed because of almost complete laryngeal obstruction.

At the time of my examination the cords were found to be in the midline position with only a 1 mm opening in the glottic space. When the tracheotomy tube was covered, the respiratory effort was greatly increased and an inspiratory crow was noted. The patient was hospitalized on March 1, 1948, and arytenoidectomy was carried out on the right side through the Lynch suspension apparatus, as previously described. The slight bleeding encountered was controlled with the electrocautery unit.

A modification of the procedure as mentioned in the report on case 2 was carried out. An O'Dwyer tube was placed between the vocal cords and anchored inferiorly to the tracheotomy tube and superiorly to the cheek. The tube was allowed to remain in position for four days. After this it was removed because of the marked edema noted around the tube. The patient was given injections of penicillin after operation. She was dismissed from the hospital on March 7. The tube was closed on the tenth postoperative day and was removed on the twenty-first postoperative day. The resulting glottic opening was 5 mm. The air-

way was quite adequate. The resulting voice was low in pitch and hoarse, but recently has shown some tendency toward improvement. She has had a 10 pound (4.5 Kg) gain in weight since operation.

SUMMARY

A new intralaryngeal approach is presented for the correction of bilateral paralysis of the vocal cords which follows removal of the thyroid gland. The results have been excellent in establishing a normal airway in 3 patients so treated. In 2 patients the voice has shown a slight improvement. In 1 patient the resulting voice was poor but adequate and recently has shown some tendency toward improvement. Recordings of the voice were made before and after operation.

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THE ANTERIOR ETHMOIDAL NERVE SYNDROME

Referred Pain and Headache from the Lateral Nasal Wall

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THE ANTERIOR ethmoidal nerve syndrome is a name suggested for a series of symptoms resulting from irritation of the terminal branches of the anterior ethmoidal nerve. The referred pains arising from this nerve are chiefly of the sinus type but may also take the form of headache, sometimes of a migrainous character. Ephedrine applied to the anterior ethmoid fissure and/or the middle turbinate body has met with considerable success in the cure of the pain and headache of this origin. In April 1947, both anterior ethmoidal nerves were severed in a particularly stubborn case. The patient had not been able to carry on with her work, but since operation she has been rehabilitated. An effort will be made to apply recent physiologic discoveries in reporting the clinical course in this case.

To Littell¹ goes the credit for having cut the anterior ethmoidal nerve in 2 cases of this syndrome, with satisfactory results. His postulate that infection in the olfactory fissure (anterior ethmoidal foramen) is the fundamental cause of irritation of this nerve is only part of the explanation, in my opinion, as judged by considerable experience with this syndrome, extending over a period of fifteen years.²

Littell described and illustrated the gross anatomy of the anterior ethmoidal nerve from its exit in the orbit, its passage below the dura and its entrance into the anterior ethmoidal foramen and so into the nasal cavity, to become the nasal nerves. He has indicated how surface pressure on the mucous membrane covering the nerve can develop in this area of the olfactory fissure and that intranasal surgical treatment may suffice in many cases.

There is additional information which should be added to this discussion, and figure 1, taken from a previous paper,³ illustrates bony

From the Department of Otolaryngology, Toronto General Hospital, University of Toronto

1 Littell, J. J. Disturbances of the Ethmoid Branches of the Ophthalmic Nerve, *Arch Otolaryng* 43 481 (May) 1946

2 Burnham, H. H. Headache from the Nasal Wall, *Ann Otol, Rhin & Laryng* 46 69, 1937

3 Burnham, H. H. An Anatomical Investigation of Blood Vessels of the Lateral Nasal Wall and Their Relation to Turbinates and Sinuses, *J Laryng & Otol* 2 569, 1935

canals within the middle turbinate body into which the minute branches of blood vessels and nerves pass. It indicates where areas of potential pressure on nerves may take place from dilatation of surrounding veins, even though surface pressure might not be present.

REPORT OF A CASE

Miss C, aged 31, was first seen March 29, 1938. She complained of bilateral pain over the frontal, parietal, occipital and vertical areas. She experienced no pain behind the eyes, but had some aching and stiffness of the neck. She had

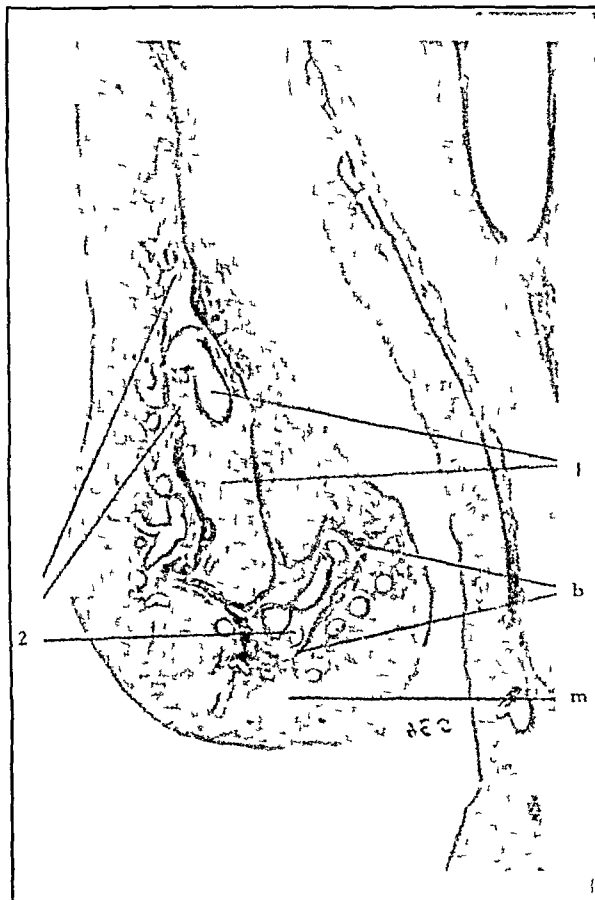


Fig 1—Cross section of middle turbinate body, showing the turbinate canal and vessels. 1, is the middle turbinate artery and the plexus about it, 2, various smaller canals which contain veins, these, in turn being continuous with vessels in the canal of the middle turbinate body, b, bone and m, mucoperiosteum, $\times 10$. From Burnham³

some pain every day, and frequently all day, for two weeks at a time, the pain even keeping her awake at night. There was stiffness of the muscles of the cheek and lower jaw when the pains were at all severe. The pain was at first a continuous ache, becoming throbbing as it grew severer and a sharp, stabbing pain occasionally when very severe. Her mother was subject to headaches.

Examination showed nothing of significance except for hypersensitive areas about the anterior ethmoidal foramen and over the course of the nasal nerves

When this area was touched lightly with an applicator, she felt as though a red hot needle had been stuck into her nose at this point

A 3 per cent solution of ephedrine sulfate was applied to this area, resulting in considerable amelioration of symptoms that day, but similar treatments twice a week for three months failed to stop the pain entirely

At this time she was in a motor accident and had a fracture of the left malar bone, and I did not see her for several months. About ten months later I saw her again, as the old pain had once more been very severe for three weeks and she felt that the nasal treatment was the only thing that did any good. With the same form of treatment, there again was slow improvement. However, she stated that she had had a better summer than for some years.

A few weeks later war was declared, and I did not see her for seven years. In the interval she had joined the naval services as an officer, and one year before I saw her again she had had a return of the pain and headache and it had incapacitated her. No nasal cause had been found, and she had been turned over to the neurologic service, where her condition was diagnosed as psychosomatic, she was treated accordingly, but without improvement. When I saw her, she was delighted, as she felt that now her pain would be relieved. However, treatment once a week over many months gave no real improvement, and she was still incapacitated. I had felt for many years that an intractable case of this kind would justify the severing of the anterior ethmoidal nerve, but I had felt that the condition would have to be very bad indeed to justify such a procedure, as it was somewhat experimental. About this time I read Littell's article¹ and was greatly encouraged to try this operation. After the patient was discharged from the services, she came to my office and requested the operation.

On April 21, 1947 I severed both anterior ethmoidal nerves and vessels at their point of entrance into the anterior ethmoidal foramen from the orbital side. I varied Littell's technic by placing a small plug of periosteum over the foramen to prevent reunion of the nerve endings.

The immediate after-course was interesting. The patient was unable to take morphine, and so pantopon® (a mixture of the hydrochlorides of the opium alkaloids) was substituted. After operation there was considerable reaction in the soft orbital tissues, and she was unable to open her eyes for six days because of edema of the lids, she suffered very severe pain for three days. The pantopon® gave her so little relief that it was thought that it might as well be dispensed with. Codeine sulfate was used alone, with amobarbital sodium (amytal sodium®), $\frac{1}{2}$ grain (31 mg), given at night. At the end of two weeks she was feeling some relief. She was still getting $\frac{1}{2}$ grain of codeine sulfate hypodermically four times daily and $\frac{1}{2}$ grain amobarbital sodium at night. The pain was still worse than before operation, as the tissue reaction had not yet subsided.

Five weeks after operation she stated that she had begun to feel much better than before operation. Seven weeks after operation she said she had been free of pain over both malar areas for two weeks. The right frontal area was better than before operation, but the left, which had lagged about three weeks behind the right side, was about the same as before operation. She decided to drive her car north to the lakes the next day. She felt much encouraged, and her friends were pleased with her improvement. She could not read long at a time, as diplopia which followed operation was still present to a slight degree. The lagging of the left frontal area, as compared with the right, was probably due to a severer reaction of the soft tissues on this side and trauma of the supraorbital nerve from pressure of the retractor during the operation.

Postoperative Course—September 30 The patient took a job in the summer and stated that her head was "an awful lot better" She still had pain in a narrow strip up the center of the forehead and about the scars No pain was felt in the other areas except for two or three days at her menstrual periods She stated that she had had less pain in the past one and a half months than since it began, twenty-one years before

November 28 She had only a little soreness at the base of the nose, this was more or less constant, but was improving After being out recently on a cold and windy day, she had had a severe pain up the center of her forehead to the hair line for two or three days The drawn expression had gone from her face, although it had been noticeable to many of us who saw her before operation The scars were barely visible

Sensation There had been astonishingly little loss of sensation as a result of the severing of the anterior ethmoidal nerves The sensations of heat, cold, touch and tactile discrimination (sharp and dull) were now practically normal except in the area over the tip of the nose, in which sensibility was still dull, but was improving The tip of the nose had felt cold at times, but this condition was improving

Oct 4, 1948 (one year five months after operation) She stated that the pain had been bad for two days in July The weather had been particularly trying, and pain occurred during her menstrual period However, the only pain she had felt was localized straight up the center of her forehead, with none at all in the face or anywhere else Slight pain occurred at her menstrual period a month later, but, except for a slight occasional headache, "such as anyone might have," as she expressed it, she had been free from pain Her family remarked on her great improvement and could not say enough about the benefit she had obtained

Test of Sensation—The tip of the nose still became cold, she stated Occasionally a watery discharge occurred from the right nostril, but none from the left The area about the scars was still tender, much as it was over a scar on her leg An applicator applied to the nasal mucosa over the anterior half, i e., the area normally supplied by the lateral nasal nerve, felt ticklish and caused her to sneeze, but, whereas this stimulus used greatly to aggravate the pain in her face and head, there was now no pain The appearance of the mucosa of the turbinate body was slightly more intumescent than it had usually been before operation and gave the impression of the vessels being more dilated and relaxed It shrank smartly after being touched with an applicator Her nose felt normal and clear.

Comment—The pain had practically stopped and was not stirred up by insertion of the applicator in her nose She felt the stimulus as a dull sensation in her face, but not as pain

The acuity of sensation of the skin of the bridge and the sides of her nose was still a little dull to sharp and dull stimuli, and that of the tip was slightly more so The area in the posterior half of the nasal mucosa, supplied by the connection with the sphenopalatine ganglion, was hypersensitive and painful to the touch

The sensation and reaction in the nasal mucosa usually supplied by the anterior ethmoidal nerve were normal, only the posterior area, supplied by the connections with the sphenopalatine ganglion, was hypersensitive

GENERAL COMMENT

A discussion of the theoretic background of the anterior ethmoidal nerve syndrome is of interest. Three recent contributions to neurophysiology are applicable to this problem, and are mentioned in the order of their publication: (1) the work of Sir Thomas Lewis in demonstrating the role played by tissue metabolites in erythralgia, i. e., a burning and redness of the skin⁴, (2) the discoveries of Granit and his associates of the neurophysiologic department of the Karolinska Institute, Stockholm, Sweden, 1944,⁵ and (3) Nathan's work on causalgia⁶.

1. In a paper published in 1937,² an effort was made to apply Lewis' theory of tissue metabolites to the problem of this particular pain and/or headache. (a) The irritation within the nasal mucosa from the products of bacterial invasion produces a hypersensitive or susceptible state. (b) As a result, substances (metabolites) normally produced in the tissues from external stimuli, such as changes of atmosphere and drafts, cause excessive stimulation of the neurovascular mechanism and sensory nerves. The headache or pain which results is in the nature of a referred pain and involves one or more branches of the trigeminal nerve. (c) The "tender spot" beneath the nasal bridge and in the area of the anterior ethmoidal foramen is believed to be due to pressure from congestion on the trunk of a hypersensitive nerve (nasal branches of the anterior ethmoidal nerve) in a bony foramen or canal, and this, in turn, may aggravate or produce the headache or pain.

2. In the work of Granit and his associates,⁵ it is shown that severing of the sciatic nerve in an animal, or even pressure on it, will cause alteration of the action current in the nerve as far as 2 or 3 cm proximal to the site of injury and that an odd reversal of currents takes place. Currents were found to pass from motor to sensory fibers of the nerve at this site and from sensory to motor fibers. A sensory to sensory fiber interaction was also demonstrated.

An application of this discovery to the present problem suggests that a traumatic condition of the anterior ethmoidal nerve may be set up by surface and/or intratissue pressure at the anterior ethmoidal foramen and the foramen of the middle turbinate body, causing interference with normal conduction of the action current, or, in other words, irritation of the nerve trunk for at least 2 or 3 cm proximal to the site of trauma at the anterior ethmoidal foramen. If the anterior ethmoidal nerve be

4 Lewis, T, and Hess, W. Pain Derived from the Skin and the Mechanics of Its Production, *Clin Sc* 4 1, 1933

5 Granit, R., Leksell, L., and Skoglund, C. R. Fibre Interaction in Injured or Compressed Region of Nerve, *Brain* 67 125, 1944

6 Nathan, P. W. Pathogenesis of Causalgia in Peripheral Nerve Injuries, *Bram*, 70 145, 1947

traced back 2 or 3 cm from the nasal cavity, the nasociliary nerve trunk is reached (fig 2), and if the electric disturbance is continued farther back, many branches of this nerve are involved, still farther back the ophthalmic nerve trunk is involved

Presumably, in Miss C's case most of the ophthalmic nerve was involved in this hypersensitive reaction, and when the pain was severe parts of the maxillary and mandibular divisions were affected, indicating involvement of the gasserian ganglion

3 In Nathan's work⁶ on causalgia, he advanced the hypothesis that pain is caused by efferent impulses in the sympathetic fibers of the nerve which stimulate the somatic afferent fibers at the point of damage, called the "artificial synapse" In other words, the outflow on the sympathetic fibers of the nerve may cause stimulation of the sensory nerve at the artificial synapse and cause pain referred to the area supplied by this nerve The particular point of trauma from pressure (the artificial

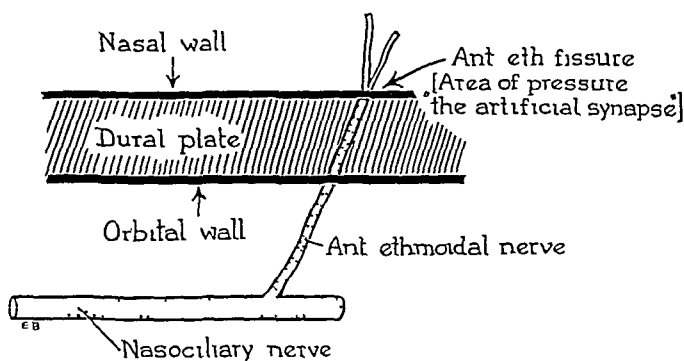


Fig 2—Diagram illustrating anterior ethmoidal nerve in relation to the surrounding area The stippled area indicates the disturbed or hypersensitive area of the nerve as a result of pressure at the anterior ethmoid fissure and/or the areas of the middle turbinate body

synapse) of the anterior ethmoidal nerve appears to be chiefly at the anterior ethmoidal foramen and, to some extent, over the bony canals within the anterior tip of the middle turbinate body This nerve is presumably sensory, being a branch of the ophthalmic nerve, and contains autonomic fibers The outflow from the autonomic nervous system would cause stimulation of the sensory nerve trunk at the artificial synapse It may be postulated that the hypersensitive state of the nerve extends centrally and may involve branches of the nasociliary nerve and, still more centrally, the frontal and lacrimal branches of the ophthalmic nerve This explains the pain in the malar area, occasional congestion of the conjunctiva, pain behind the eyeball, and pain in frontal and supra-orbital areas, the root of the nose, the center of the forehead and the parietal area

In the present case, the question arises as to why the patient occasionally had pain up the center of the forehead. This is the area supplied by the supratrochlear branch, which is therefore part of the ophthalmic nerve trunk from which the anterior ethmoidal nerve was given off. This nerve trunk was hypersensitive for many years, pain being touched off frequently by a hypersensitive anterior ethmoidal nerve. It is therefore to be expected that a terminal branch of this nerve may still have a low threshold for pain and that the stimulus producing pain in this nerve is due to a still hypersensitive nerve trunk rather than to a nerve center origin. The fact that it is giving less and less trouble would indicate that, with elimination of the trigger area, i. e., the anterior ethmoidal nerve, the nasociliary nerve connection is almost back to normal. The course of the illness in this case would indicate that the hypothesis of a hypersensitive nerve trunk, as indicated by physiologists, is a better explanation of the action of a trigger area than the irritation of nerve centers alone and that elimination of the trigger area will allow recovery of the whole nerve mechanism involved.

That a hypersensitive nerve was cut through explains why the pain in this case was worse immediately after sectioning and then gradually improved after the trigger area had been eliminated.

The history and course of the disturbance in this case emphasize the importance of locating a trigger area and eliminating it by treatment—medical if possible, surgical if necessary—rather than by treating the psychoneurosis alone. The latter aspect has been overemphasized in recent years. In a very high percentage of cases the anterior ethmoidal nerve syndrome will respond to conservative treatment, as outlined in "Headache from the Nasal Wall," and it is only rarely that drastic surgical intervention is necessary.

SUMMARY

The anterior ethmoidal nerve syndrome is a name suggested for a series of symptoms resulting from irritation of the terminal branches of the anterior ethmoidal nerve.

A case is described in which both anterior ethmoidal nerves were severed, with relief of the referred pain.

An explanation for this anterior ethmoidal nerve syndrome is suggested, based on neurophysiologic discoveries, the theory of tissue metabolites proposed by Lewis and the demonstration of nerve fiber interaction.

Medical Arts Building

CHORDOMA OF THE MAXILLARY ANTRUM AND NARES

Report of a Case Clinically Resembling Hodgkin's Disease First Diagnosed
by Biopsy of a Cervical Node

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AND

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CHORDOMAS in the maxillary antrums and nares are extremely rare. Rarer still are chordomatous metastases to cervical lymph nodes. Only 3 previous cases, those of Peters,¹ Potoschnig² and Lewis,³ have been found with positive involvement of cervical nodes. Bailey and Bagdasar⁴ thoroughly covered the history of chordoma from 1846 to 1929, and the origin and development of the notochord was aptly discussed anatomically by Huber.⁵ The classification supplied by Coenen⁶ is the most complete and satisfactory. This briefly recognizes three major groups: cranial, vertebral and sacrococcygeal. Under the first major cranial group, a fourth dental subgroup includes maxillary and mandibular chordomas.

Concerning biopsies, Adson, Kernohan and Woltman⁷ stated

But biopsy, too, may present difficulties, as was experienced by Hirsch, from whose patient repeated specimens taken from a tumor in the tonsillar region resulted in such a wide variety of diagnoses and comments by eminent pathologists as almost to drive him to despair, a terse diagnosis of chordoma finally settled the

From the Departments of Otolaryngology, Surgery and Radiology of the Medical College of Virginia

1 Peters, W. Chordoma with Metastases, *Deutsche Ztschr f Chir* **151** 191, 1919

2 Potoschnig, G. Ein Fall von malignem Chordom mit Metastasen, *Beitr z path Anat u z allg Path* **45** 356, 1919

3 Lewis, N D C. A Contribution to the Study of Tumors from the Primitive Notochord, *Arch Int Med* **28** 434 (Oct) 1921

4 Bailey, P., and Bagdasar, D. Intracranial Chordoblastoma, *Am J Path* **5** 439, 1929

5 Huber, G C. On the Anlage and Morphogenesis of the Chorda Dorsalis in Mammalia, in Particular the Guinea-Pig, *Anat Rec* **14** 217, 1918

6 Coenen, H. Das Chordom, *Beitr z klin Chir* **133** 1, 1925

7 Adson, A W., Kernohan, J W., and Woltman, H W. Cranial and Cervical Chordomas. Clinical and Histologic Study, *Arch Neurol & Psychiat* **33** 247 (Feb) 1935,

issue Until the pathologist had been informed that the tumor extended into the retropharyngeal space, he had had, as may well be imagined, great mental hazards to surmount

In another case they stated that " in spite of the fact that the tumor had originated from the region of the sphenoid-occipital synchondrosis and had invaded the surrounding bone, little evidence of destruction of bone was seen in the postmortem roentgenogram"

Hass,⁸ in 1934, collected 56 cases of chordoma of the cranial vault, the region of the cranium, the cervical portion of the spine and the nasopharynx and listed 77 pertinent references from the literature and added a very complete case report of his own A history of trauma could be obtained in a high percentage of cases The average age of the patients was 36 years Pain in the neck or arms was almost invariably an early symptom Bulbar symptoms, partial obstruction of the nasopharynx so that there was difficulty in breathing and various cranial nerve involvements followed from eight months to eighteen years after the onset of symptoms In 2 instances, lateral extensions were palpable in the posterior cervical triangle Two of his statements warrant quotation

Furthermore, nasopharyngeal chordomas were described in patients who had no signs or symptoms referable to a tumor at the base of the brain

Whenever anterior extension occurred it was customary to find ventral invasion of bone and soft tissues The infiltration of bone which was usually symmetrical was not always restricted to the basisphenoid and the body and sinuses of the sphenoid bone The regional petrous portions of the temporal bones, the ethmoid sinuses as far forward as the crista galli and the osseous walls of the orbital cavities were involved with ventral invasion into the walls of the nasal fossae and into the superior maxillary bones with the tumor encroaching on the nasal cavities, the maxillary antrums and the soft tissues of the face In one instance the temporal bone was penetrated by tumor which continued its invasion into the temporal muscle

Owen, Hershey and Gurdjian⁹ in 1932 reported the case of a 52 year old Italian cement worker with pain in his neck and both shoulders and arms, more pronounced on the left, involving the cervical portion of the spine They detailed other case reports from the literature in 8 of which the tumor was believed to have originated in the cervical portion of the spine, in 2, from the odontoid process, in 1, from an intervertebral disk, and in 4, from vertebral bodies, in 2 the exact origin was unknown They added

In all cases that were examined by x-ray the diagnosis of tuberculosis was made although in our case secondary cancer was suspected We believe from this

8 Hass, G M Chordomas of the Cranium and Cervical Portion of the Spine Review of the Literature with Report of a Case, *Arch Neurol & Psychiat* 32 300 (Aug) 1934

9 Owen, C I, Hershey, L N, and Gurdjian, E S Chordoma Dorsalis of Cervical Spine, *Am J Cancer* 16 830, 1932

standpoint alone, that in the consideration of tuberculosis of the cervical spine, chordoma must always be kept in mind as a possibility. There seems to be no typical x-ray picture of chordoma in the cervical region.

In 3 cases, the tumor grew anteriorly, in 1 it grew in the lateral aspect of the neck, and in 2 a mass projected into the pharynx.

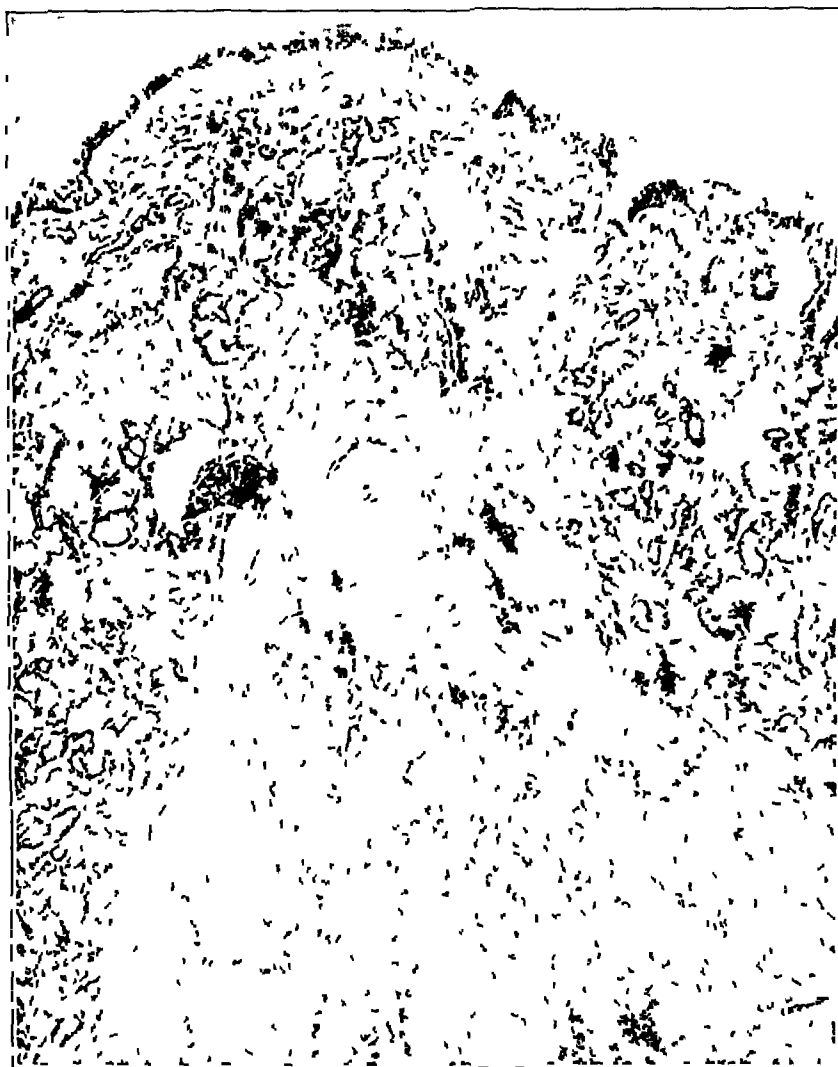


Fig 1—Low power view showing the schneiderian membrane with the mucous gland and the tumor pushing from underneath the membrane.

In 1938, Ridpath¹⁰ found 12 cervical, 52 sphenoid-occipital (10 nasopharyngeal) and 91 sacrococcygeal tumors in patients with an average age of 36 years. He reported 2 cases from the otolaryngologic point of view, that of a woman of 43 years and that of a man aged 38 years.

¹⁰ Ridpath, R. F. Chordoma, with Report of Two Cases, *Ann Otol, Rhin & Laryng* 47: 649, 1938.

Stewart and Morin¹¹ reported the case of a man aged 59 years with increased swelling of the throat and left side of the neck. A firm swelling behind the postpharyngeal wall from the level of the upper part of the larynx led to the removal of the growth through an external lateral incision. There was destruction of the third cervical vertebra.

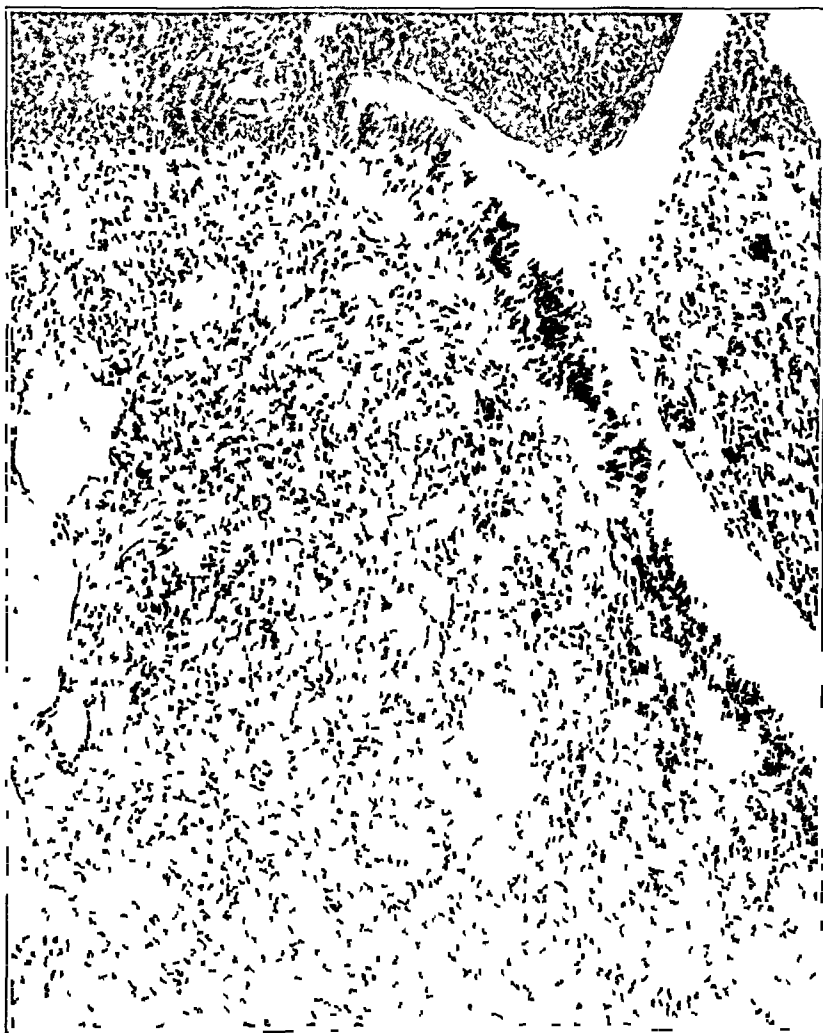


Fig 2—A low power view showing tumor cells with inflammatory cells very close to the schneiderian membrane

Cappell¹² studied chordomas of the vertebral column, thoroughly reviewed the literature and found 77 cases reported up to 1928, he added 3 more cases, 2 in the cervical and 1 in the thoracic region.

11 Stewart, M. J., and Morin, J. E. Chordoma. A Review with Report of a New Sacrococcygeal Case, *J. Path. & Bact.* 29: 41, 1926.

12 Cappell, D. F. Chordoma of the Vertebral Column, with Three New Cases, *J. Path. & Bact.* 31: 797, 1928.

Radiation therapy has almost universally proved to be unsatisfactory in chordomas of all regions. Daland¹³ in 1919 treated a mass below the right mastoid process in a woman aged 30 years, first with two massive doses with a total of 5 roentgen treatments, and a seven month follow-up showed recurrence of the mass following surgical intervention plus roentgen therapy. Stewart and Morin¹¹ said that, "probably

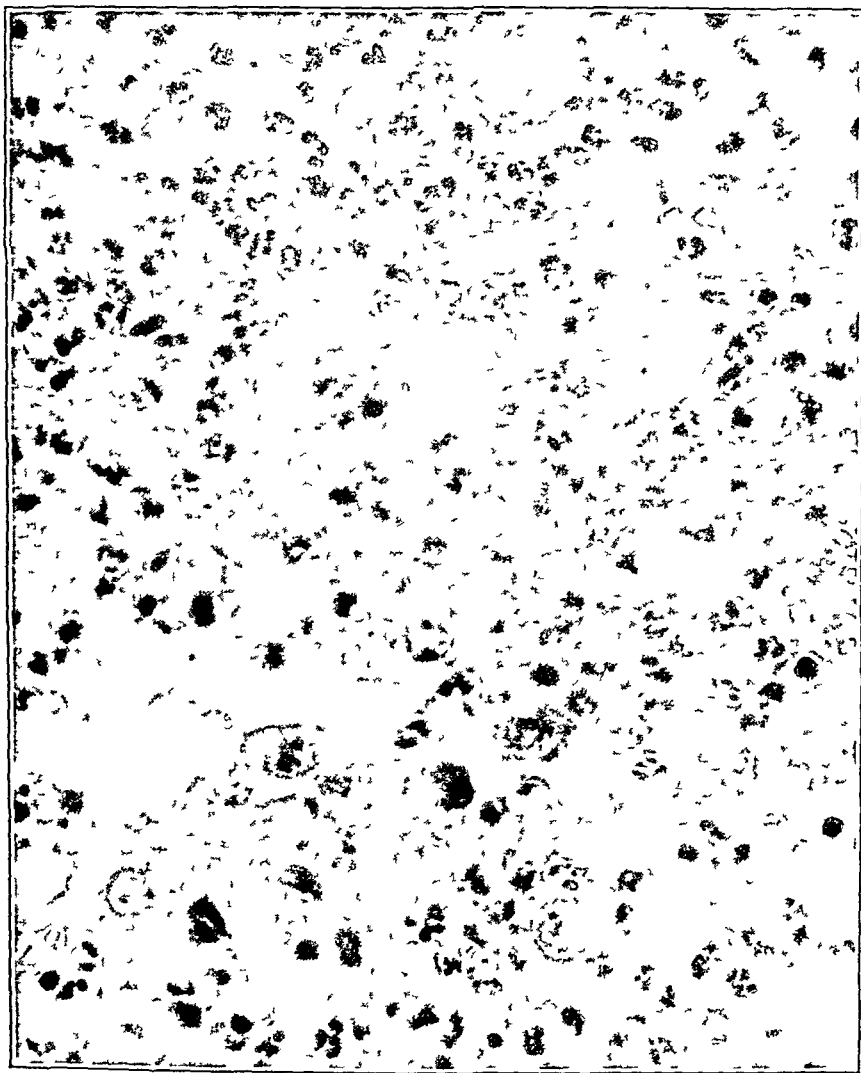


Fig 3—Nests of tumor cells and discrete tumor cells bathed in the inflammatory exudate

on account of the indolent, slowly growing character of these tumors, treatment by radiation is almost without effect." Dickson and Lamb¹⁴ reported a 2 cm tumor area in the sacrum of a 41 year old man in which incomplete removal was followed by 900 r and then 160 r repeated

¹³ Daland, E M Chordoma, Boston M & S J 180 571, 1919

¹⁴ Dickson, J A, and Lamb, C A Sacral Chordoma, Ann Surg 93 857, 1931

three times They felt that roentgen treatment apparently had been successful in checking development of the neoplasm No metastases were found Hass⁸ quoted Goerke, who stated that "a combination of roentgen and thorium therapy was thought to be of value in one instance" Owen, Hershey and Gurdjian⁹ tried high voltage roentgen therapy and thought it showed little effect in the way of result However, this observation was based on observations on 1 case after three months'

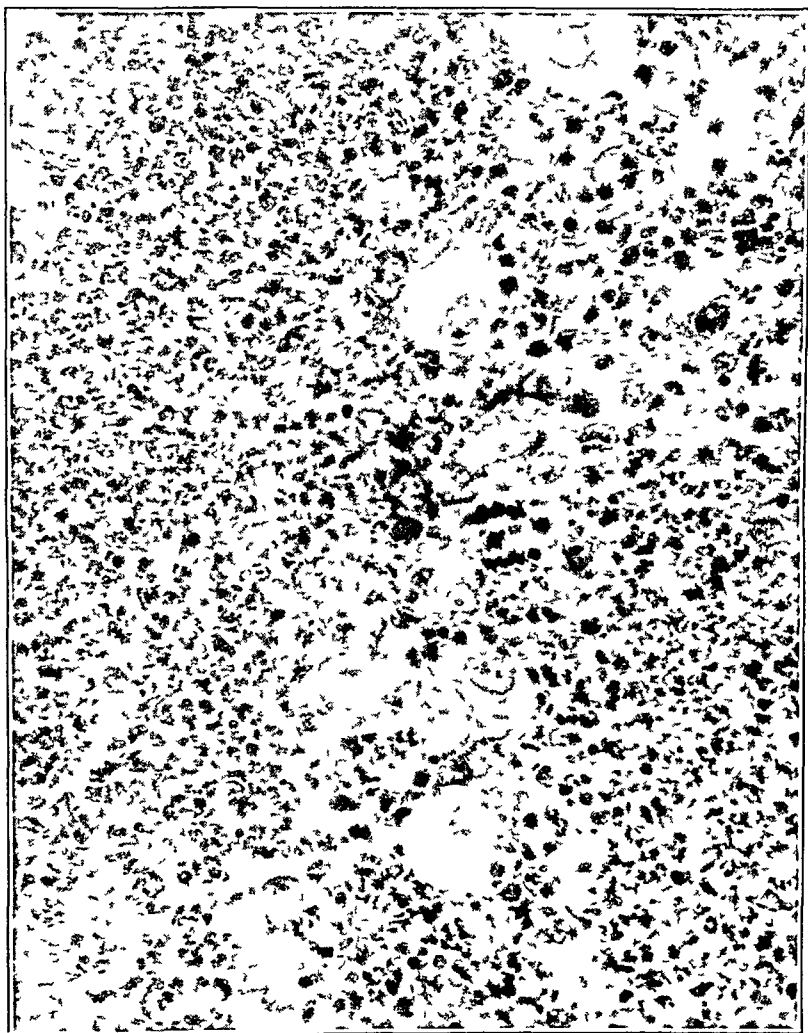


Fig 4—High power view showing nests of tumor cells, the most central cells of which are becoming vacuolated and ballooned (physaliferous)

follow-up Adson, in discussing Van Wagenen's¹⁵ paper, said, "It is my impression that all these tumors are malignant and some more malignant than others"

15 Adson, A W, in discussion on Van Wagenen, W P Chordoblastoma of the Basilar Plate of the Skull and Ecchordosis Physaliphora Spheno-Occipitalis Suggestions for Diagnosis and Surgical Treatment, Arch Neurol & Psychiat 34 548 (Sept) 1935

Adams¹⁶ recently reported a case of chordoma of the right frontal sinus in a 64 year old woman with dense sclerosis of the frontal bones around sinuses which were small but roentgenologically clear. Biopsy showed a cellular tumor with well defined cells with clear cytoplasm and small hyperchromatic nuclei. A 4,000 r surface dose to each of

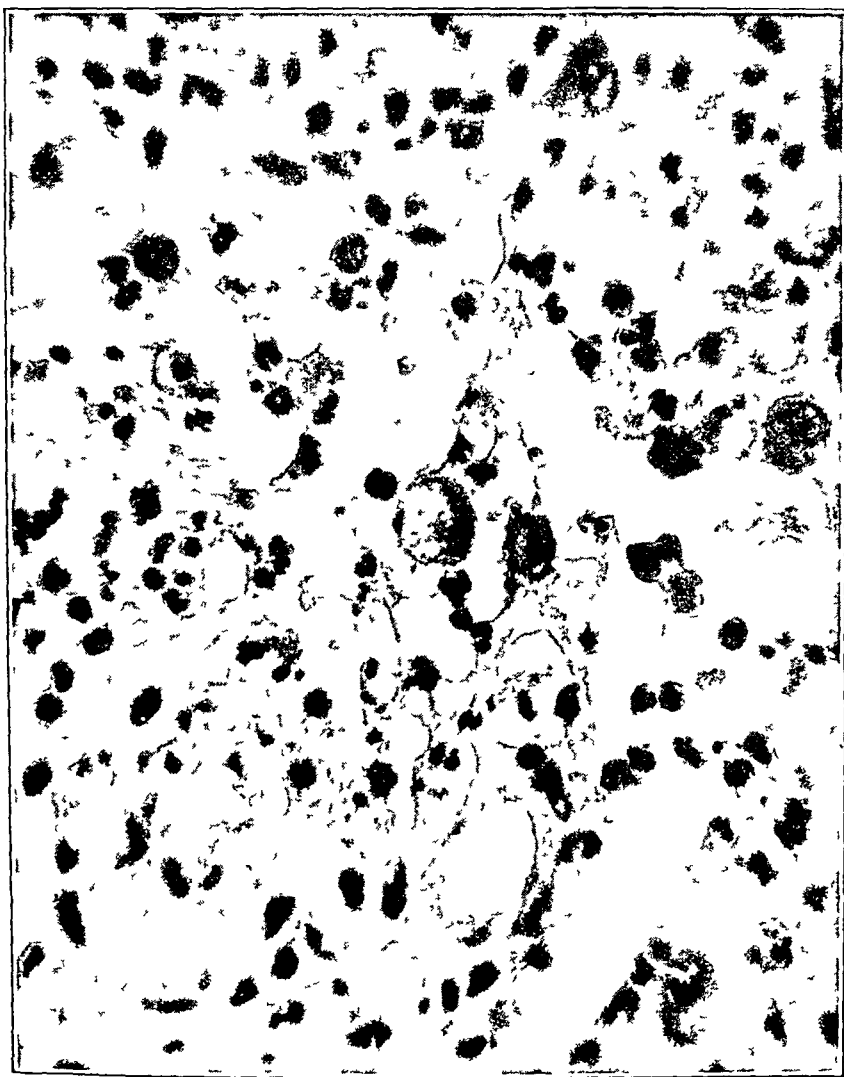


Fig 5—High power view showing the tumor cells undergoing mucoid degeneration. In the center of the field is one tumor cell with a large vacuole encroaching on the nucleus and producing a signet ring pattern.

two 5 cm fields was followed by erosion of the floor of the right frontal sinus during the next six months. Biopsy of the frontal sinus membrane showed tumor still present. No metastases or extensions were present over one year later, and the operative site was healed.

¹⁶ Adams, W S. A Case of Chordoma of the Right Frontal Sinus, *J Laryng & Otol* 62 93, 1948

Harvey and Dawson¹⁷ noted that "the chordoma which had been described in the region of the maxillary antrum might possibly be confused with a parotid tumour but this is an unlikely site for the chordoma except as a late extension from the sella turcica"

REPORT OF CASE

A married white woman, aged 21 years, was first admitted to the Medical College of Virginia Hospital for a forceps delivery at term The past history

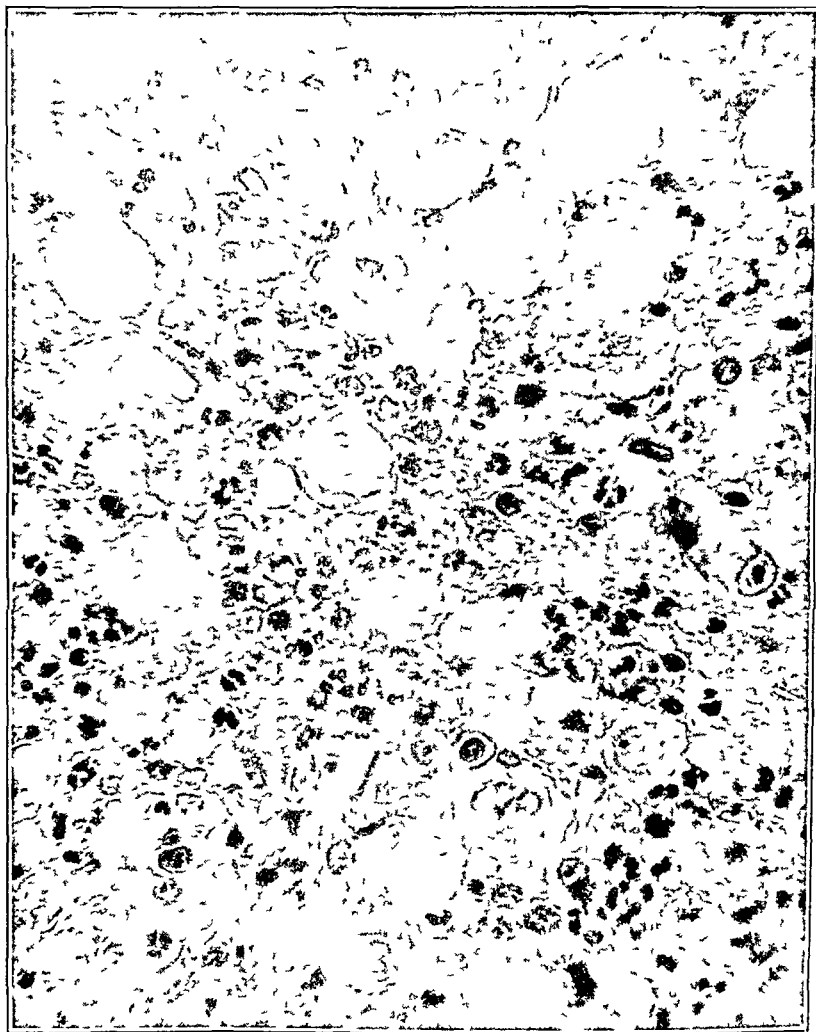


Fig 6—High power view showing multinucleated tumor cells and discrete tumor cells with a ring around them resembling plant cells

showed measles, mumps, chickenpox, pneumonia and mastoiditis on the left, all early in childhood, before the age of 12 years Tonsillectomy and adenoidectomy had been performed at the age of 12 The neck was free of palpable masses at that time A routine flocculation test for syphilis elicited a negative reaction

17 Harvey, W F, and Dawson, E K Chordoma, *Edinburgh M J* 48 713, 1941

The second admission was to the outpatient department ten years and three months later. The left ear had continued to discharge intermittently for twenty years. This discharge was usually more profuse during attacks of common colds. Two months before this admission she had noted pain and progressive swelling in the region of the left side of the neck, just under the mastoid process and behind the angle of the lower jaw. Her family physician had referred her to a surgeon, who had advised roentgen therapy, and four small doses of roentgen rays had been given at another hospital without obvious change in the size of the moderate-sized cervical mass.

Otolaryngologic examination showed the following positive findings at this time. There was an anterior superior perforation of the left tympanic membrane with slightly purulent drainage. The nasopharynx, nose and pharynx appeared perfectly clear. There was an irregular, nodular, firm, moderately fixed mass of nodes in the left cervical region just behind the angle of the jaw.

Roentgenograms of the mastoids in the Law and Towne positions showed chronic sclerotic changes in the left mastoid process. There were no erosions of the petrous ridges, sella turcica or foramen magnum or evidences of destructive or productive changes in the sphenoid and occipital bones.

After several days' observation, the 4 cm mass in the left cervical region and a portion of the left sternocleidomastoid muscle and its sheath were removed by a general surgeon.

Adequate pathologic sections were examined by three pathologists, with one diagnosis "indeterminate," a second "metastatic carcinoma" and a third "Hodgkin's disease in which the granuloma has undergone a transition to sarcoma."

One month later a small, walnut-sized, mass appeared on the superior aspect of the left shoulder and three smaller nodules in the left preauricular, left posterior cervical and right midcervical regions, respectively.

Three months after the removal of the left cervical mass, for a period of fifteen months, with a clinical working diagnosis of Hodgkin's disease, based on the third microscopic diagnosis, and the lack of evidence of any site of primary carcinoma after numerous medical, neurosurgical and roentgen consultations, the patient received the following roentgen therapy:

Region	Date	Portal, Cm	No of Doses	Individual Dose, r (Afr)	Total Dose, r
Half Value Layer, 0.9 Mm Copper					
1 Left cervical	9/ 2/47 9/22/47	10 × 15	8	150	1,200
2 Left outer supraclavicular	11/11/47 12/15/47	8 (circular)	10	200	1,950
			9	200	
3 Left inner supraclavicular	1/19/48- 2/23/48	8 (circular)	11	200	2,100
			10	200	
4 Left cervical	9/19/48- 5/ 3/48	10 × 15	8	200	1,600
Half Value Layer, 0.5 Mm Copper					
5 Right cervical	7/22/48 8/ 1/48	10 × 15	18	100-150	2,250
6 Left cervical	7/23/48- 8/ 1/48	10 × 15	18	100-150	2,250
7 Left axilla	10/15/48 10/18/48	10 × 15	3	250	750
Half Value Layer, 0.9 Mm Copper					
8 Posterior thoracic spinal	10/16/48 10/18/48	20 × 8	2	200	400
9 Right lateral cervical	12/10/48 12/16/48	10 × 15	6	200	1,200

During this period the patient showed diminution in the size of the nodules treated, apparently an immediate response of the lymphoid tissue making up the bulk of the masses to the radiation. There was never complete disappearance of the nodelike areas. Pain and discomfort varied greatly in the left facial, cervical and shoulder regions. There was a loss of weight of 25 pounds (11.3 Kg), and anorexia and nausea which occurred were attributed to the radiation therapy.

A third admission to the hospital one year after the removal of the cervical tumor mass was necessary for the performance of a therapeutic abortion in the sixth week of pregnancy

A fourth admission was necessary three months later because of left nasal obstruction, severe pain, discomfort and swelling of the entire left side of the head and neck. Review of the sections from the cervical mass and lymph nodes by an experienced pathologist revealed "chordoma"

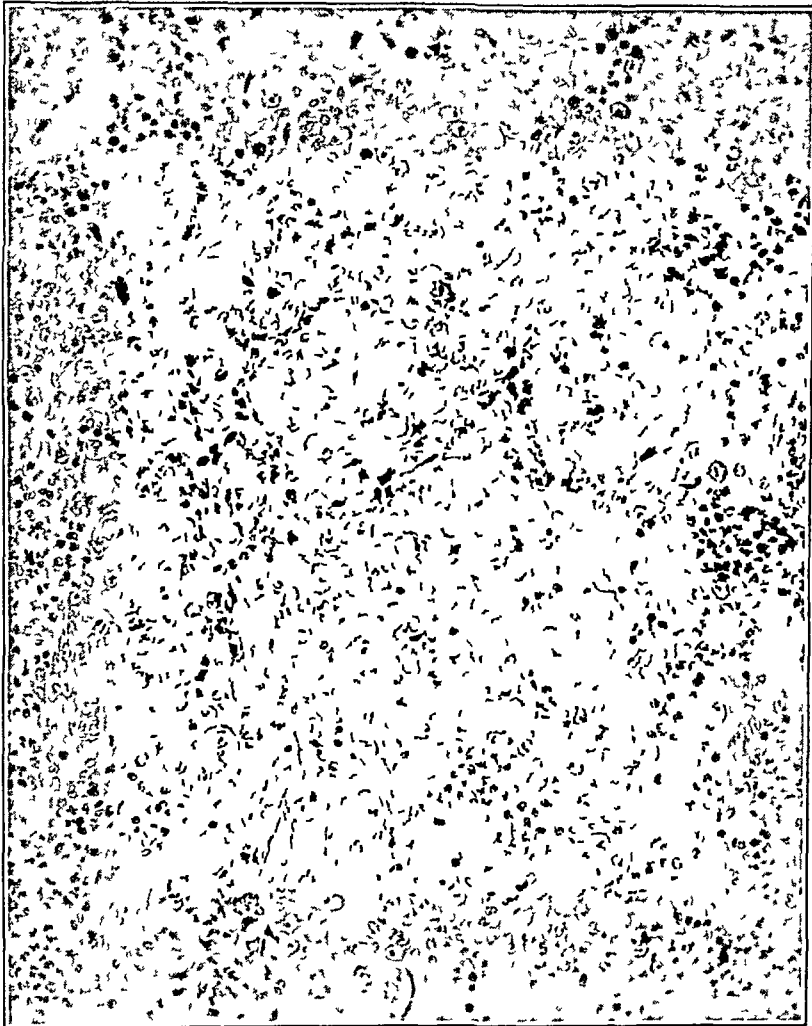


Fig 7—Medium power view showing a pattern similar to that of lymphoepithelioma

Complete neurosurgical examination in the light of this diagnosis with roentgenograms of the skull, cervical thoracic and lumbosacral portions of the spine and chest showed no evidence of sphenoid-occipital, cervical or sacral chordoma. Roentgenograms of the nasal accessory sinuses showed complete clouding of the left maxillary antrum and densities in the left nares.

Otolaryngologic examination showed the same perforation of the left tympanic membrane with profuse foul drainage. Both nasal passages were obstructed, the turbinate tissue of the left side having a pale, blue waterlogged appearance, with excessive tenacious polypoid plastic exudate completely filling the passage. The

nasopharynx was filled with this type of material, which seemed to originate in the left antrum

On Oct 16, 1948 the patient was given an intravenous dose of one of the nitrogen mustards and intramuscular injections of penicillin were started. Polypoid masses were removed from the left side of the nose and adjacent nasopharynx anteriorly. She was discharged from the hospital and followed in the outpatient clinic.

A fifth admission was necessary the following month because of severe pain in the left antral and cervical regions, and the neurosurgical department felt that the left gasserian ganglion was involved. On November 27 the otolaryngologic service performed a tympanomastoidectomy on the left (radical). Penicillin was given intramuscularly. The left nasopharynx and nasal passage was again obstructed, and polypoid masses appeared to have grown rapidly since the previous removal from the left antrum. The polypoid masses were made up of whitish gray material. The largest measured 1 cm in its greatest diameter.

Microscopically the sections showed fragments of tissue of different types: 1 In some there was necrotic material with pus cells and hemorrhage; 2 In some there was vascular granulation tissue with leukocytes and tumor tissue; 3 In some there was normal schneiderian membrane (stratified columnar ciliated with stroma and glands) covering tumor tissue.

The structure of the tumor was very pleomorphic and to the casual observer confusing owing to the inflammatory process. The cell types presented (a) sheets of large cells with large vesicular nuclei, each containing two to three or more nucleoli, (b) syncytial masses with two to three or more nuclei, (c) cell nests in which the central cells were very large with foamy vacuolated cytoplasm (physaliferous), (d) cell nests in which the cells were very large with granular acidophilic cytoplasm. Some of these were beginning to become vacuolated, and some had become signet ring shaped. In these areas, there were large vacuolated masses, which had lost their nuclei. Here, coarse glycogen granules were demonstrable with Best's carmine stain. The granular nonvacuolated cells did not show glycogen granules. (e) Few mitotic figures were found, and these were in the granular cells. The pathologic diagnosis (P. F. S.) was chordoma.

Two months later the patient died, Jan 14, 1949, in another local hospital, and necropsy was not obtained.

SUMMARY AND CONCLUSIONS

From the histologic picture presented in this case, in a 32 year old white woman, it becomes obvious that a review of the histogenesis of chordoma is indispensable for a differential diagnosis.

Chordomas originate from remnants of the primitive notochord. The primitive notochord is entodermal according to some and mesenchymal according to others. However, since there is no other tissue to behave like it and since it retains its individuality although it is closely enveloped and surrounded by mesenchymal structures, the concept of the French school as quoted by Harvey and Dawson,¹⁷ that it originates *suu generis*, becomes very appropriate.

The tumor has many of the morphologic characteristics of cartilage, while it expands, infiltrates and even metastasizes like carcinoma. The tumor cells in certain instances may be large with clear cytoplasm.

and distinct cell membranes and surrounded by hyaline and/or mucinous material and suggest the diagnosis of chondroma. However, other areas may show sheets of pavement cells, the most central of which are large and vacuolated (physaliferous) as seen in the illustrations. Some of the nests may be surrounded by hyaline bands. Mitotic figures are usually rare. This is the type which simulates carcinoma. When a chordoma of this type invades a lymphoid structure, as the nasopharynx or the cervical lymph nodes, the resulting picture may simulate a lympho-epithelioma or even Hodgkin's sarcoma. The differential diagnosis depends on the finding of the physaliferous cells and the vacuolated cells, as well as the paucity of mitotic figures, and clinically on its slow course and precarious response to irradiation therapy.

DENTAL CONSIDERATIONS IN FITTING HEARING AID EAR INSERTS

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NEW ORLEANS

ABOUT three quarters of a million hearing aids are sold annually in the United States, and the medical literature contains many articles concerned with the proper technic of fitting them. It is now generally agreed that if a hearing aid is to be used in aural rehabilitation it must be tailored to measure to give optimum results in each particular case.

An important part of this custom tailoring process is the fitting of the ear piece, or insert. In recent years it has been recognized that personal ear fittings must be used to get the best air conduction reception. Lederer and Hardy¹ found that a poorly fitting ear insert may lessen the efficiency of a vacuum tube hearing aid by as much as 20 decibels. They conclude "Nor can too much emphasis be placed on the care with which the 'tailoring' of the ear mold is done." This is interesting, for it is commonly known that almost all the ear inserts sold are fitted by lay persons—hearing aid salesmen and saleswomen—who have no medical or dental background. It is our contention, based on facts to be presented, that even better results can be obtained if certain anatomic factors are taken into consideration before construction of the ear inserts.

REQUIREMENTS FOR A WELL FITTED EAR INSERT

The most important requirements that should be met by any well fitted ear insert are (1) that it should be comfortable and (2) that it should provide good acoustic seal, i e, there should be no leakage or escape of sound around the insert.

The necessity for comfort is obvious. Wearing a hearing aid is in itself a bother to the average person, and an uncomfortable insert would become such an unbearable nuisance that the wearer would soon want

From the Hearing Clinic of the Eye, Ear, Nose and Throat Hospital

¹ Lederer, F L., and Hardy, W G. Treatment and Training of the Hard of Hearing, Arch Otolaryng 43 429-461 (May) 1946

to discard the aid. We are of the opinion that buffing down rough edges and projections is not the complete answer to the problem, for often this is done with a sacrifice of snugness of fit and a loss of acoustic seal.

It is necessary to have the best acoustic seal possible, because leakage of sound decreases the efficiency of even the best aids. This decrease in efficiency is brought about because with leakage there is a weakening of most of the sounds reaching the middle ear. To compensate for this weakening a higher acoustic output must be used, and the higher the output the less the sensitivity. Another result of leakage is the squeal of acoustic feed-back.

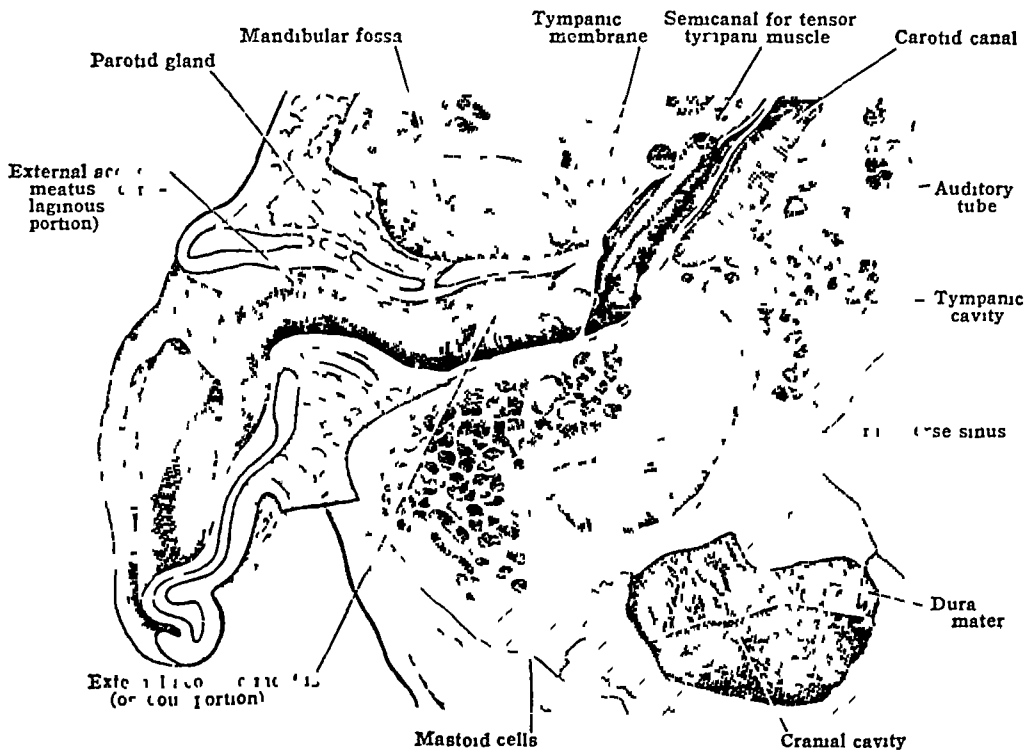


Fig 1—Horizontal section through the right ear showing close anatomic relation between the mandibular fossa and the mobile cartilaginomembranous portion of the external auditory canal. It is not difficult to see how abnormal condylar movements are transmitted to the mobile portion of the canal. (From Morris, H., and McMurrich, J. P. *Morris's Human Anatomy*, ed 10, Philadelphia, The Blakiston Company, 1942)

CONSIDERATIONS IN FITTING INSERTS

Anatomic—A consideration of the anatomy of the external auditory meatus into which the ear mold is inserted will reveal some interesting facts (fig 1).

We shall concern ourselves principally with the outer one third of the external meatus. This portion is cartilaginomembranous and mobile. One can demonstrate mobility by placing the small finger in the external

auditory canal while going through the acts of opening and closing the jaws. This mobility is due to the anatomic relation of the external canal. The anterior wall is in relation with the temporomandibular articulation and with the parotid gland. The gland is also in relation with the floor of the canal. Movement of the mandibular condyle is transmitted through the gland to the cartilaginous portion of the canal, which is drawn forward when the mouth is opened and compressed when it is closed.

When the joint functions correctly, movement of the canal wall is at a minimum for the individual person. On the other hand, when there is retraction of the condyle of the mandible, *i. e.*, when the condyle is pushed posteriorly, the movement of the canal wall may be considerable. Between optimum functioning of the joint and pronounced dysfunction are many stages with varying degrees of movement of the external canal. Needless to say, the more movement there is, the more difficult it will be to obtain comfort and good acoustic seal when fitting an ear insert. Therefore, for the best possible fit of an ear insert, retraction of the mandibular condyle should be looked for, and, if present, the causes should be removed so that the condyles may be placed in their correct anatomic positions in the joint.

Dental—Retraction of the mandibular condyle is due most frequently to malocclusion of the teeth, *i. e.*, abnormality of the contact relation of their biting surfaces. Because, as Goodfriend² pointed out, the various movements of the mandible start from and return to centric occlusion of the teeth, an abnormal centric occlusion causes abnormal movements of the mandible and mandibular joints. As previously mentioned, this abnormality is transmitted to the external auditory canal.

Probably the commonest cause of abnormalities of centric occlusion is loss of permanent teeth in various numbers with inadequate replacement. Thus there results a disturbance in the normal arrangement of the occlusal relation of the upper and lower teeth.

A consideration of the frequency of loss of teeth at various ages should prove interesting. Table 1 is a compilation of the percentage loss of teeth during the ages of 10 to 75, based on 9,450 cases studied by Brekhus.³ It shows that at the age of 20 up to 47 per cent of the persons studied had lost the lower first molar. After 20, the loss is progressively rapider. Members of the dental profession know this tooth as the keystone of the dental arch, for it is the first permanent tooth to erupt and around it all the rest of the teeth are arranged. Although the first molar is very important, it is well also to consider the loss of

² Goodfriend, D. J. Deafness, Tinnitus, Vertigo and Neuralgia, *Arch Otolaryng* 46 1-47 (July) 1947.

³ Brekhus, P. J. *The Loss of Human Teeth*, Minneapolis, University of Minnesota Press, 1928.

other teeth, particularly after 40, the age after which most hearing aids are worn Brekhus³ presented also the percentages of edentulous mouths in men and women between the ages of 20 and 70 (table 2)

TABLE 1*—*Relative Loss of Teeth, Expressed in Percentages, During Ages From 10 to 75 in Male and Female Patients*

Teeth Lost	Sex	Ages													
		10	15	20	25	30	35	40	45	50	55	60	65	70	75
Lower six	M	10	30	40	45	50	55	63	70	72	77	80	85	88	90
	F	15	35	47	57	65	72	75	78	82	83	86	88	92	92
Upper six	M	5	15	23	35	40	50	55	62	69	75	81	86	89	93
	F	5	15	23	35	40	56	67	72	78	80	85	88	92	93
Upper five	M	0	3	11	18	29	40	48	57	62	68	75	80	86	90
	F	0	3	14	30	41	55	65	72	78	82	85	90	92	93
Upper four	M	0	4	11	18	29	37	46	55	62	67	75	80	86	90
	F	0	3	14	27	40	55	63	73	77	82	84	88	91	94
Lower seven	M	0	2	8	16	25	35	45	55	63	67	76	82	87	90
	F	0	3	17	25	39	50	62	70	76	80	85	88	92	95
Upper seven	M	0	0	3	12	21	33	44	60	64	73	79	83	90	93
	F	0	1	10	20	32	45	58	68	73	78	82	88	92	93
Lower five	M	0	3	9	13	19	26	33	41	49	56	64	70	75	79
	F	0	3	12	22	30	42	50	60	65	72	76	80	86	90
Upper two	M	0	2	6	10	20	30	39	48	55	62	69	74	81	85
	F	0	2	13	18	33	41	53	63	69	75	80	86	89	96
Upper one	M	0	0	2	10	18	25	35	44	51	60	68	75	82	89
	F	0	2	10	18	29	40	50	60	67	75	79	83	89	94
Upper three	M	0	0	½	6	14	22	32	45	49	58	66	75	82	88
	F	0	0	6	15	26	40	50	60	67	72	78	81	87	95
Lower four	M	0	0	1	6	10	15	23	30	40	47	58	64	70	73
	F	0	2	4	9	17	26	36	45	54	64	70	75	82	86
Lower one	M	0	0	1	2	6	12	20	28	39	48	58	65	72	76
	F	0	0	3	6	10	17	26	33	43	50	60	68	78	86
Lower two	M	0	0	¼	1	6	12	20	28	39	48	58	62	70	74
	F	0	0	2	4	10	16	26	36	43	54	60	66	78	86
Lower three	M	0	0	¼	1	4	7	15	23	33	42	53	60	66	69
	F	0	0	1	4	9	16	25	36	41	53	60	65	78	85

* From Brekhus³ The percentages were based on a series of 9,450 patients

TABLE 2*—*Percentages of Edentulous Mouths in a Series of Men and Women Between the Ages of 20 and 70*

Age	Men			Women		
	Upper Jaw	Lower Jaw	Entire Mouth	Upper Jaw	Lower Jaw	Entire Mouth
20	1	0	0	0	0	0
30	8	3	3	20	8	8
40	26	13	13	43	21	20
50	44	29	28	60	40	39
60	62	47	46	73	57	55
70	76	58	56	86	78	76

* From Brekhus³

In such cases there is no occlusion, and those patients who wear hearing aids should receive particular attention, for even though they wear complete upper and lower dentures there may be a loss of vertical height or intermaxillary distance, causing retraction of the mandibular

condyle This loss of vertical height may be due either to improper construction of the dentures or to alveolar resorption following the wearing of dentures that had been properly constructed when first applied

DIAGNOSIS OF CONDYLAR RETRACTION

The diagnosis of condylar retraction is not difficult and has been thoroughly discussed by Goodfriend²

The first procedure is to feel the movements of the condyles during the opening and closing of the jaws by placing the fingers over the joints Normally the movements are smooth, abnormally, there is lateral displacement or an uneven movement In the second step the tips of



Fig 2—(a) Measurement A, the distance from the center of the pupil to the corner of the lip, normally should be the same as measurement B In this patient, who has worn the same complete set of dentures for twenty years, A measured 71 mm (b) Measurement B, distance from the base of the nose to the mental point of the chin, measured 58 mm—a loss of 13 mm in vertical height or intermaxillary distance There was considerable movement of the outer third of the external auditory canals

the little fingers are placed in the external auditory canals and the movements of the condyles are felt during speaking, swallowing, chewing, yawning, etc When normally positioned, the condyles do not cause encroachment on the lumen and there is minimum movement of the external canal, abnormally, crepitus, jerky movements and encroachment on the canal are felt This maneuver will also reveal inequality in movement of the two condyles

The final procedure is to determine whether or not overclosure of the jaw with loss of vertical height or decrease in intermaxillary dis-

tance is present This is done by comparing the measurement from the point of the pupil to the corner of the lip (measurement A) with that from the base of the nose to the mental point of the chin (measurement B) These measurements are illustrated in figure 2*a* and *b* Normally, A equals B, with overclosure, A is greater than B When the latter condition exists, there is said to be a loss of vertical height, a condition always accompanied with abnormal movements of the condyles and, hence, of the external auditory canal The actual measurements may be made with a rule graduated in millimeters We have found it convenient, however, to use the B-D facial surveyor⁴ and feel that this is a more accurate method

To determine the incidence of excessive movement in the external auditory meatus due to abnormal condylar motion, 100 hard of hearing patients were investigated Forty-eight of these patients were wearing hearing aids, and 52 should have had them Their ages ranged from 7 to 85 years, all but 12 being 35 years old or more Using the diagnostic procedure previously outlined, we found that 80 per cent of the patients showed malocclusion with abnormal movement of the mandibular condyles This condition was not taken into consideration, to the patient's knowledge, in a single case among the users of hearing aids when their ear inserts were being made Sixty per cent of the hearing aid wearers were dissatisfied with the aids because of complaints that could possibly have been due to an ill fitting ear insert

CONCLUSIONS

It is our contention, therefore, that if the best possible results are desired with a hearing aid an occlusal survey should be made This means that there should be close cooperation between the otologist and the dentist in fitting ear inserts When the difficulty is slight, there will be little need of corrective measures On the other hand, such restorative measures should be seriously considered when there is marked encroachment on the canal, this is particularly important for those patients who are edentulous If they were cared for, there would be fewer people who are forced to remove the ear insert of their hearing aid when eating or yawning because of the effects produced by improperly fitting dentures

There is, we feel, still another benefit to be derived from restoring normal centric occlusion in many hard of hearing patients This is in reference to the well established, but infrequently considered, part played by malocclusion in the production of conduction deafness There is no agreement as to the exact pathogenesis of this condition, but there are many cases recorded attesting to the benefit derived from correction of

4 Manufactured by the Bee-Dee Distributors, New York

the bite In addition, we have in our files records of patients who have shown as much as a 25 decibel gain in audition from no treatment other than restoration of normal centric occlusion Most of the patients requiring a hearing aid have either mixed or conduction deafness If in a part of these persons deafness is based to some extent on abnormality of the temporomandibular joint, then it is logical to assume that once this difficulty is cared for there will be some lessening in the degree of their conduction deafness If this is accomplished, the acoustic output of the hearing aid used could be lower The tremendous benefit derived from lessening the acoustic output is obvious, for it is well known that the lower the acoustic output needed by the patient, the more satisfied he will be with the reception of the instrument

SUMMARY

Although most hearing aid ear inserts are now individually fitted, insufficient consideration is given to the abnormal movement of the cartilaginous portion of the external auditory canal which may occur as a result of retraction of the mandibular condyles posteriorly

The principal cause of abnormal condylar movement and position is malocclusion, the presence of which is not difficult to determine That malocclusion is widespread in the population is evident from the results of a survey made by Brekhus on the loss of permanent teeth, the principal cause of malocclusion This survey also revealed that in the age group in which most hearing aid users are found the incidence of malocclusion is greatest

It is pointed out that if the hearing aid user is to get comfort and good acoustic seal with his ear insert, movements of the external auditory canal should be minimized In 80 per cent of the cases studied this would have required a restoration of normal centric occlusion

In addition to greater comfort and better acoustic seal, reestablishment of normal centric occlusion may cause some decrease in the conduction element of the deafness under consideration With this decrease a lower acoustic output could be used and more satisfactory reception would result

It is concluded that for the optimum fitting of hearing aid ear inserts cooperation of the otologist and the dentist is necessary in a large proportion of the cases

Case Reports

PLASMA CELL TUMOR SIMULATING BILATERAL MAXILLARY SINUSITIS

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Recognition of plasma cell tumors of the upper respiratory system and particularly of the accessory nasal sinuses has increased since attention has been called to their incidence by New,¹ Claiborn,² Jackson³ and others. The otolaryngologist finds these tumors of particular interest because of their occurrence in the upper respiratory tract and, especially, in the maxillary sinuses. The plasma cell tumor is generally considered to arise from the bone marrow although many cases of extraosseous origin have been reported. The classic multiple myeloma is thought to be a disease of the bone marrow or of the blood-forming structures generally, and, while the plasma cell tumors seem to be a phase in the developmental history of multiple myeloma, the cause and nature of these tumors are not definitely known and their exact relationship to multiple myeloma⁴ is not clear.

If the plasma cell tumor should be regarded as arising in the hemopoietic system, particularly the lymphocytes, such a premise might explain the occasional extraosseous occurrence of the tumor—in the soft tissues, such as the tongue, tonsils, pharynx and cheek.⁵ To carry this premise further, later multiple involvement of marrow may represent a fundamental pathologic change in the hemopoietic system. Microscopically, the plasma cell tumor presents a predominance of plasma cells, with evidence of mitosis throughout the tissue.

In all instances of plasma cell tumors reported in literature, the symptoms associated with the tumors have varied with the location and activity. Thus, when the soft tissues of the face are involved, there is a gradually increasing swelling. In the oropharynx, the symptoms are referable to the act of swallowing, later in the progress of the disease, should there be invasion of the intracranial cavity diplopia and unilateral exophthalmos are evident. The subjective symptoms in the case herein presented were typical of chronic maxillary sinusitis. However, since the plasma cell tumor usually grows at a rapid pace, the progressive symptoms

From the Department of Otolaryngology, Gallinger Municipal Hospital

1 New, G B, and Harper, F R. Plasma Cell Myeloma of the Pharynx Without Skeletal Involvement, *Arch Otolaryng* **16** 50-54 (July) 1932

2 Claiborn, L N, and Ferris, H W. Plasma Cell Tumors of the Nasal and Naso-Pharyngeal Mucosa, *Arch Surg* **23** 477-499 (Sept) 1931

3 New, G B, and Childrey, J H. Tumors of the Tonsil and Pharynx, *Arch Otolaryng* **14** 713-730 (Dec) 1931

4 Ewing, J. Neoplastic Diseases. A Text-Book on Tumors, ed 3, Philadelphia, W B Saunders Company, 1928, p 420

5 Figs, F A, Broders, A C, and Havens, F Z. Plasma Cell Tumors of Upper Part of Respiratory Tract, *Ann Otol, Rhin & Laryng* **54** 283-297 (June) 1945

come on at an equally rapid rate, usually from six months to one year after the first early symptoms⁵

It is further reported that in plasma cell tumors of the accessory sinuses roentgenographic studies reveal a more extensive involvement of bone than would be expected from the clinical examination, considerable erosion of the surrounding bony structures can be seen. This was so in the case here reported, both the lateral wall of the left orbit and the infraorbital plate being considerably involved.

In none of the reported cases have laboratory studies been of great value in early diagnosis of the plasma cell tumor. Presence of Bence-Jones protein in the urine is rarely reported in cases of plasmacytoma prior to development of the multiple osseous lesions, which is rather late in the course of the disease. Nor do the changes in the blood smear and alterations in the blood count serve as diagnostic aids from all reports, since both types of changes are slight⁵

All authors are in accord that the plasma cell tumors are very sensitive to radiation and that once the diagnosis has been made irradiation is the treatment to be given. In fact, the disease has been reported held in check for many years with radiation therapy. However, it is warned that a guarded prognosis should be made, since there is always the possibility that the generalized multiple myeloma will arise at a later time, despite an apparent complete cure, the tumor must be regarded as highly malignant, and the patient should be kept under observation over a long period⁵

The case to be reported illustrates many of the salient features of the plasma cell tumor previously discussed.

REPORT OF CASE

A Negro man, aged 60, was first seen in the outpatient clinic on Nov 18, 1948, complaining of bilateral nasal obstruction, constant rhinorrhea and vasomotor symptoms. He stated that some two months earlier he had noticed nasal obstruction, first on one side and then on both sides, there was constant mucopurulent discharge, associated with a sensation of fulness in the antral region. There was no sinus pain. The left eye had been irritated for a period of three weeks. The patient did not complain of other physical ailments, and there had not been any loss of weight.

General physical examination revealed nothing significant except for pathologic conditions in the nose and throat. Examination of the nose revealed formation of polyps on both sides, so extensive that they protruded from the vestibule. The sinuses were not tender. A profuse mucopurulent discharge was evident in both nostrils. There was dacrocystitis on the left associated with the purulent conjunctivitis. The oropharynx and hypopharynx were normal. However, the nasopharynx when examined with a mirror showed what appeared to be polypoid tissue which filled the upper third of the space. The ears were normal except for moderate retraction and thickening of the tympanic membranes.

Roentgenologic study of the sinuses revealed definite and profuse haziness of both antrums. The remaining sinuses were essentially normal. On the basis of this diffuse haziness, irrigation was done, a greenish yellow purulent material was obtained. Since the patient did not show improvement, subjectively or objectively, after several irrigations, a study of the antrums was made after injection of iodized oil U S P, each antrum accepted only 1 cc of oil, and the subsequent roentgenogram revealed a marked filling defect suggestive of the presence of extreme polypoid degeneration or a tumor bilaterally.

Biopsy of the nasal polyps disclosed only the pathologic changes typical of a nasal polyp.

A bilateral Caldwell-Luc operation was performed. At the time of operation, the antrums were found completely filled with what appeared to be an organized necrotic inflammatory tissue which bled easily and which was firmly attached to the walls of the antrums but was not typical of antral polyps in appearance. In removing this tissue, a pathologic dehiscence was found in the nasoantral wall and in the floor of the orbit.

The results of microscopic study of this tissue were reported as follows: "There are groups of completely arranged cells which are irregularly trabeculated with narrow connective tissue bands and throughout which there are small fat cells. The medium-sized cells have a relatively large, usually round or ovoid nucleus, resembling plasma cells. Mitotic figures are seen throughout the slide."

The patient suffered no ill effects from the operation. He was discharged seven days later and was asked to return to the clinic within the second day, however, he did not return for three weeks. At that time examination disclosed a large mass on the right cheek. The left eye was proptosed and fixed. The patient complained of diplopia and blurring of vision. He had lost some weight.

Roentgen irradiation was begun, the total dose was 1,500 r to each antrum and 1,500 r each to the right and left zygomatic region. The patient made remarkable progress as a result of this treatment. The left eye returned to its normal position, and there was a return of function of the extraocular muscles. The plasma cell tumor tissue in the nasopharynx and in the nose itself seemed to have disappeared. Laboratory examinations revealed no abnormal conditions. Bence-Jones protein was not found. Roentgenograms of the long bones and scalp revealed no other lesions.

When the patient was seen June 1, 1949, there were no signs or symptoms of the disease.

COMMENT

The plasma cell tumor herein described is interesting in that it simulated a chronic maxillary sinusitis. The case shows the importance of careful microscopic study of all tissues removed at the time of operation, whether the tissue is thought to be a simple polyp or diseased tissue present in an antrum. The present case also serves to emphasize the occurrence of this neoplasm in the accessory sinuses, particularly in the antrums. Early diagnosis is important because of the efficacy of radiation in treatment of this type of tumor. However, from all reported instances, an over-all poor prognosis may be expected, since it has been found that even after an interval of seven to ten years the neoplasm may recur as multiple myeloma in other locations.

CONCLUSIONS

Plasma cell tumors of the maxillary sinuses are increasingly recognized, and an early diagnosis can be made, radiation therapy instituted in the early stages has brought remarkably quick improvement. But owing to the frequent development of multiple myelomas in later years, the prognosis can never be considered good. Pathologic studies of all tissues is of the utmost importance in diagnosing the plasma cell tumors.

RECOVERY IN OTITIC PNEUMOCOCCIC MENINGITIS

L. C. BOEMER, M.D.
ST. LOUIS

A woman aged 55 retained good hearing practically unchanged after removal of the malleus, incus and drum membrane during the course of acute otitis media, mastoiditis and meningitis. She had been examined a month prior to her present illness, when her hearing for the whispered voice was within normal limits but audiometric examination showed moderate decibel loss bilaterally. Subsequent examinations were made with the same audiometer and under the same conditions.

The initial cell count of the spinal fluid was 9,000 per cubic millimeter. It is recognized that the higher the count and the older the patient, the less the chance for recovery.

The intracranial pathway of extension of the tympanomastoid infection was not demonstrable at the time of operation, it may have been through venous channels. Various routes of intracranial extension, such as via the subarcuate fossa from infected paratubal cells, through the dura beneath the gasserian ganglion and from infected paratubal cells into the carotid canal, were shown by studies of serial horizontal sections of the middle ear and the mastoid in 26 cases of pneumococcic and in 13 cases of streptococcic meningitis occurring during the period from 1929 to 1932.¹ Although all deaths were proved to have resulted from meningitis secondary to the infection of the middle ear and the mastoid, the drum membranes had returned to an approximately normal macroscopic and microscopic picture, as shown in the photomicrographs and published cases.

Before the days of chemotherapy and use of the antibiotics, many patients with protective meningitis—that is, meningitis with no organisms demonstrable in the cerebrospinal fluid—were saved by drainage, removal of feeding foci and other measures. Rare was the patient with streptococcic infection—and rarer the patient with pneumococcic meningitis—who was saved.

The patient in the present report had had no previous aural infection to her knowledge. At the onset of her illness, she experienced a frontal headache for thirty-six hours and then became unconscious. On her entry to the hospital, she had been unconscious for seven hours. The right drum membrane was found red and bulging and was immediately incised, yielding serosanguineous exudate. The spinal fluid, with a count of 9,000 cells per cubic millimeter, yielded a pure culture of pneumococci. The first recorded temperature (rectal) was 105.5 F, the white blood cell count was 12,900, with 43 per cent stab cells, 44 per cent segmented forms and 13 per cent lymphocytes. Daily laboratory examinations showed progressive improvement in the patient's condition. Two days after admission to the hospital she showed occasional rational response, and in four days she was fairly rational. Lumbar puncture, with intrathecal injection of 25,000 units of penicillin,

From the Department of Otolaryngology, St. Louis University School of Medicine.

¹ Boemer, L. C. Some Observations on Temporal Bone Sections and Otitic Meningitis, *Ann Otol, Rhin & Laryng* 42:866, 1932.

was made twice daily for two days and then daily for ten subsequent days, with the intrathecal injection of penicillin omitted after the seventh day

The temperature curve did not approximate normal until five days after tympanomastoid drainage (two weeks after the patient's admission to the hospital) Penicillin was given intramuscularly every two hours for four weeks, 500,000 units on admission, 100,000 units for two days and then 30,000 units until the day of the exploratory mastoidectomy, when the dose was increased to 100,000 units, with reduction to the preoperative dose in two days

Sulfadiazine was given to maintain levels of from 8 to 13 mg per hundred cubic centimeters On the patient's fifteenth day in the hospital, leukopenia, with a count of 3,300 cells, developed Sulfadiazine was discontinued, and in two days the white cell count had risen to 6,800 Lactated Ringer's solution U S P with 5 per cent dextrose was given subcutaneously and intravenously in the amount of 5,400 cc during the first eighteen hours and 3,000 cc daily through the sixth day in the hospital, when the patient was able to take fluids by mouth On her ninth day

Results of Audiometric Tests

Decibels	Right Ear			Left Ear	
	March 3, 1947	July 16, 1947	Nov 15, 1948	March 5, 1947	Nov 15, 1948
128	15	15	5	15	0
256	5	20	20	0	5
1024	20	20	15	5	5
2048	15	15	25	5	10
4096	25	25	55	5	10
8192	55	75	70	65	50
11584	Not heard at any examination date by either ear				

in the hospital (two days after ventriculograms failed to show evidence of cerebral abscess), with slight tenderness and edema still remaining over the right mastoid bone, tympanomastoid operation was performed, with the patient under thiopental sodium (pentothal sodium®) anesthesia The mastoid cells were soft in places and hemorrhagic throughout Minimal granulations were present in the antrum and the aditus The malleus and incus were removed and the drum membrane was excised subtotally, an anterior 2 mm rim being permitted to remain

The tympanomastoid cavity was completely epithelized and dry by the twentieth postoperative day Hearing for the whispered voice approximated normal limits, between 20 and 40 feet (6 and 12 meters), and remains unchanged at the time of this report Audiometric findings were not essentially changed by the operation or illness, considering the 10 decibel factor of error

Comment—It is considered that the rim of the drum membrane, permitted purposely to remain, grew together with connective tissue and squamous epithelium to cover the stapes in such a way as to permit fairly normal hearing

Beaumont Medical Building

Abstracts from Current Literature

Ear

USE OF NITROFURAN THERAPY IN EXTERNAL OTITIS JACK R ANDERSON and
C H STEELE, *Laryngoscope* 58 1279 (Dec) 1948

Most external otitis is of bacterial rather than of fungous origin Nitrofurazone (furacin®) solution 1 500 is an effective germicide After the ear has been thoroughly cleansed, the solution is placed on a cotton wick, which is inserted and left in place for twenty-four hours The patient keeps the wick saturated with the solution by adding some periodically If a fungous infection is suspected, a meta-cresylacetate-thymol solution is used also Three treatments are all that are usually necessary, relief being obtained relatively quickly HITSCHLER, Philadelphia

PRACTICAL ASPECTS OF LABYRINTHINE TESTS GORDON D HOOPLE, *Laryngoscope* 59 12 (Jan) 1949

Vertigo is becoming more common To determine the cause is often difficult A careful history and physical examination, including that of the hearing, are necessary, as well as labyrinthine tests The combination of the three will give a reasonably good diagnosis

The labyrinthine tests should be practical Much detailed information is not to be anticipated from these, and such observations as can be made may be more confusing than helpful

Various methods of performing these tests are discussed The Hallpike-Cawthorne procedure is preferred It is described in detail It consists essentially in douching each ear with water slightly above and slightly below body temperature

HITSCHLER, Philadelphia

THE ROLE OF VIRUS INFECTIONS IN THE ETIOLOGY OF SEROUS OTITIS MEDIA
HAROLD G TOBEY, *Laryngoscope* 59 35 (Jan) 1949

The incidence of secretory otitis media has increased greatly in recent years There must be other causes than that of mechanical obstruction of the eustachian tube, in fact, obstruction may have little to do with the condition Politzer said that the discharging of fluid into the tympanic cavity was due mostly to inflammation of the mucous membrane of the middle ear Some years ago such inflammation resulted in severe acute otitis media and often mastoiditis, now the insidious mild secretory otitis results Chemotherapy cannot completely account for this change, rather, an avirulent bacterium or a virus is thought to be present

Symptoms, signs and stages of the disease are described

Poltzerization may clear up the condition, or myringotomy, sometimes repeated, may be necessary In some cases the cells of the mastoid process become involved, necessitating their removal

The occurrence and importance of secretory otitis media should not be overlooked

HITSCHLER, Philadelphia

Pharynx

THE USE OF BISMUTH IN TONSILLITIS W STIRK ADAMS, Birmingham M Rev 15 171 (Oct) 1947

Mr Adams, Honorary Surgeon of the Ear, Nose and Throat Department, United Hospital and Children's Hospital, Birmingham, England, discusses the use of bismuth compounds in tonsillitis, reviewing the reports of some British and American authorities He quotes J F Lewis, who stated that the organisms

etiologically responsible in acute follicular tonsillitis are fusiform bacilli and spirochetes, and not the streptococcal or hemolytic agents, as usually reported

The author summarizes and concludes as follows

"1—A review of the original articles by Monteiro, and of published reports by all observers since, supports the conclusion that treatment by bismuth compounds controls the infection in acute non-specific tonsillitis and reduces the illness to a period of twenty-four hours in children and forty-eight hours in adults

"2—The disadvantages of intramuscular injections of bismuth salts are considered and rectal administration in suppository form is advocated

"3—The evidence for the etiological organism responsible for acute tonsillitis is considered, and on clinical grounds it is concluded that acute follicular tonsillitis is a spirochaetal disease

"4—The economic value of the treatment is evident and the discomfort to the patient of an injection is abolished"

The following doses are recommended for injection

"Adult—Bis sodii tartrate mgm 25 (approx 5/13 grain) aq sterile ad 1 cc

"Infant—Bis sodii tartrate mgm 25 (approx 5/130 grain) aq ad 1 cc"

For rectal suppositories, this prescription is given

"Adult—Bis sodii tartrate mgm. 50 (approx 5/6 grain) cocoa butter ad 1 gramme (15 grains)

or

bis sodii tartrate mgm 50, glyco-gelatin ad 1 gramme"

GORDON, Philadelphia

Larynx

THE TREATMENT OF INTRINSIC CANCER OF THE LARYNX JOHN D KERNAN,
New York State J Med 48 178 (Jan 15), 1948

Dr Kernan states that 95 per cent of intrinsic cancers of the larynx arise from the vocal cords Satisfactory management calls for (1) complete removal of the primary growth and (2) removal or destruction of all lymphatic involvement One has a choice of radiotherapy or surgery, or both Radiotherapy destroys cells according to their sensitivity Young cells and tissues in which the cells divide frequently are more sensitive to destruction than others Too much radiation will, to be sure, destroy deep, resisting cells but will also cause the death of fairly normal cells Dr Kernan states "no radioresistant cancer, situated in a vital area, can be justifiably treated by radiotherapy"

Radiosensitivity and radiocurability are not always synonymous Objections to radiotherapy are based on the fact that 96 per cent of these cancers are squamous celled and not commonly radiosensitive, and on the fact that if radiotherapy fails surgical treatment is difficult or impossible These objections are no longer completely valid in these days of better radiotherapy, for if treatment is successful the patient has a healed larynx without deformity and a useful voice

If surgical treatment is chosen, laryngofissure is the operation of choice for early intrinsic laryngeal cancer The patient should be hospitalized a week or ten days preceding the operation, and preparation should be complete in every detail To prevent postoperative infection, penicillin is given in doses of approximately 100,000 units daily during the preparation period The choice of anesthesia should be left to an expert anesthetist In Europe, local blocking of the cervical plexus is common, in America, most surgeons prefer general narcosis In any case, the cough reflex must be kept intact, for hemorrhage and pneumonia are common complications Kernan describes the methods of intralaryngeal removal originated by Lynch and continued by LeJeune

Laryngofissure gives good results in early intrinsic cancer, that is, when there is mobility of the cords, no invasion of the arytenoid cartilages and no extension to the lymphatics. This operation is contraindicated when the ventricular band, the subglottic space or an arytenoid cartilage is involved. The operation is described in detail, it does not vary from the classic procedure, but various points are emphasized. (1) The interior of the trachea and larynx are anesthetized by the instillation of a few drops of 10 per cent solution of cocaine hydrochloride between the tracheal rings. [ABSTRACTER'S NOTE—This is the so-called "tranquil tracheotomy" of Dr St Clair Thomson.] (2) Blood must be kept out of the lower airways. (3) "Excision of the growth is carried out so as to leave a surrounding free margin of tissue by making a straight vertical incision with scissors toward the arytenoid region above and below the growth, taking in, of course, the whole thickness of the tissue." (4) A bronchoscope is passed through the tracheotomy opening, and all fluid is removed. (5) The raw surfaces are powdered with sulfadiazine, and the soft parts are closed in layers.

Postoperative care calls for a semireclining or sitting position of the patient, retention of the tracheotomy tube for twelve to twenty-four hours, administration of sterile water by mouth for twenty-four hours, a fluid diet, gavage when necessary, continued administration of penicillin and removal of granulations as required. Healing takes place in two or three months. Total laryngectomy is reserved for invasion of the lymphatics or of parts external to the larynx.

Dr Maurice Lenz speaks in the discussion of the joint observations which he and Dr Kernan had carried on for seventeen years at the time of the report. Of 128 patients treated by roentgen therapy, 30 were free from clinical evidence of cancer for five to fourteen years afterward, but treatment failed in all 26 cases of cancer of the piriform sinus. Necrosis of cartilage was not unusual, but roentgen therapy "in early cancer of the cords gives as high a cure rate and a better voice than laryngofissure."

VOORHEES, New York

NERVE BLOCK THERAPY FOR PAIN OF LARYNGEAL TUBERCULOSIS. E. M. PAPPER and E. A. ROVENSTINE, New York State J. Med. 48:622 (March 15) 1948.

Working in the Department of Anesthesia, Bellevue Hospital, the authors treated 15 patients who had the distressing symptoms of dysphagia and exquisite pain.

Entrance is made in the midline just above the thyroid notch with the patient in a supine position, and the needle is advanced toward the hyoid cornu and stopped just below it, where infiltration is desired. Into the superior laryngeal nerve, which also contains some motor elements, 2 cc of 2 per cent solution of procaine hydrochloride is injected. Ten minutes later, 2 cc of absolute alcohol is instilled at this site. Immediate relief is obtained for weeks or months. Some 15 patients were thus treated with bilateral injections when pain was intense during deglutition and phonation. All these patients had advanced pulmonary tuberculosis, and all died later. The course of the disease was not altered by the procedure. Three patients had only partial relief, failures occurred in the treatment of 2 patients. Two required a second nerve block, but relief was gained at both sittings. Diagrammatic drawings illustrate the surgical anatomy and the method of injection.

(ABSTRACTER'S NOTE—While such injections are not new in a broad sense the approach is different from that in ordinary use, in which the injection is made into the superior laryngeal nerve at the point where it passes over the thyroid cartilage into the larynx.)

VOORHEES, New York

CARCINOMA OF THE ESOPHAGUS WITHOUT DYSPHAGIA ABRAHAM W FREIREICH,
New York State J Med 48 911 (April 15) 1948

This report was made before the clinical conference of the Fourth Medical Division, Bellevue Hospital, Nov 24, 1947. It concerns the case of a man of 79 with weakness, anorexia, an episode of alternating diarrhea and constipation and a weight loss of 25 pounds (11.3 Kg) of two months' duration. An unusually complete physical examination was made, however, the patient was too severely ill for esophagoscopy. The gastrointestinal tract was studied only at each end. A roentgenogram of the chest showed widening of the supracardiac aorta. In the discussion, Dr Emanuel Appelbaum states that dysphagia is early and persistent in cancer of the esophagus. Metastasis is frequent and is also early, but symptoms may be indefinite when no compression of the lumen is present. In fact, cases have been described in which cancer of the esophagus was determined only after death. The autopsy report, by Dr Henry Spitz, describes the main lesion, at the level of the bifurcation of the trachea, as a fungating, ulcerated, circular mass, the lumen of the esophagus was about normal. Microscopic examination revealed a squamous cell carcinoma which had widely and diffusely invaded the external esophageal wall. This was an example of an occult condition with nothing specific in the history, physical findings or laboratory reports. "Even the terminal events are nonrevealing."

VOORHEES, New York

Nose

REPAIR OF THE SEPTAL PERFORATION A RHINOLOGIC PROBLEM A RHINOPLASTIC
APPROACH (AUTHOR'S TECHNIQUE) ROBERT C SEELEY, Laryngoscope 59
130 (Feb) 1949

Seeley reviews the literature on septal perforations and presents a new surgical method of closure. Ten etiologic factors are mentioned. The medical treatment and the already known surgical technic are reviewed. The new procedure is shown in detail. It consists of a double flap repair allowing the continuity of the mucous membrane of the septum to be restored, leaving no raw areas. This is accomplished by mobilizing of the mucous membrane from the cartilaginous and bony portions of the inner nose continuous with that of the septum. The membranous perforation is then sutured and the flap reapplied.

HITSCHLER, Philadelphia

PROBABLE NASAL DIPHTHERIA, WITH OBSERVATIONS ON SCHICK TESTS JOSEPH
S FEIBUSH, New York State J Med 47 2600 (Dec 1) 1947

Feibush speaks of "the rising incidence of diphtheria noted by observers in Europe, Nova Scotia and upstate New York," and emphasizes "eternal vigilance" in holding this disease in check. The report concerns a 4½ year old boy with a purulent discharge from the left nostril and a thick, yellowish membrane extending from the floor of the nose up along the lateral wall. There was no fever. A culture was reported by the health department to be positive for diphtheria bacilli. Nasal cultures from the patient's father, mother and sister, made at intervals of approximately two weeks, were all negative. Penicillin was given locally by means of drops and nasal packs. A 12,500 unit dose of antitoxin was given intramuscularly. No foreign body was found. There was extension to the throat, a culture was positive for diphtheria bacilli. The author describes Schwarz's reported experiences with the Schick test, which were favorable. His own conclusions are that all children should have the Schick test and a control test three to six months after the last immunizing dose, if the reaction is positive, a course of secondary immunization with alum-precipitated diphtheria toxoid should be given, followed by the Schick test, a combined reaction should result in reim-

munization without a Schick test, the Schick test should be repeated before the child enters school

[ABTRACTER'S NOTE—It is not clear why the author uses the word "probable" in his report. The reported condition seems to be nasal diphtheria, with extension to the throat, as might have been expected. The author delayed for a month examination for a foreign body, which is important in all one-sided purulent nasal conditions, and especially in a case in which there is no fever.]

VOORHEES, New York

PSYCHOSOMATIC RHINORRHEA AND PSYCHOSOMATIC DYSPNEA LOUIS STERNBERG,
New York State J Med 48 639 (March 15) 1948

Sternberg, working in the Department of Allergy, Beth Israel Hospital, New York city, differentiates true allergy from the psychosomatic type due to antigen-antibody reactions. Two cases are reported in which there was no antecedent infection although the resemblance to hay fever in 1 and to bronchial asthma in the other was great.

A premedical student with a family history of allergy suffered sneezing and other signs of nasal discomfort during the summer of 1944, at which time she was tense and anxious. The symptoms continued until September, when she became well, to continue so throughout the winter. In the spring of 1945, she entered medical school, began to worry and had a return of all the symptoms. Laboratory tests were negative for pollens and other substances. She soon began to enjoy her studies and did well in examinations, all symptoms disappeared completely during 1946 and 1947.

The second patient had been married at 14 and divorced twice, she had then married a man sixteen years older than herself. Severe asthma developed four years later, becoming worse when the patient quarreled with her husband. Reactions to skin tests were negative. Treatment with autogenous sputum vaccine gave no improvement. The husband died. Eight months later, the patient reported that she had "been perfectly well since." In both cases, the precipitating cause was set down as "psychic stress and strain." Complete recovery occurred when this was relieved.

VOORHEES, New York

BACTERIAL FILTRATES AND AUTOGENOUS VACCINES IN THE TREATMENT OF
CHRONIC SINUS DISEASE AND OTHER CHRONIC RESPIRATORY AFFECTIONS.
PRELIMINARY REPORT HUGH M. KINGHORN, GEORGE E. WILSON and
MORRIS DWORSKI, New York State J Med 49 41 (Jan 1) 1949

This study was made in Saranac Lake, N. Y. It concerns results obtained with bacterial filtrates and autogenous vaccines in the treatment of "intractable conditions." There were 47 patients suffering from various infections of the respiratory tract—chronic sinusitis and "catarrh", cough and sputum after surgical treatment of the chest, symptoms such as these where surgical intervention was contraindicated, bronchiectasis, and allergic bronchitis. The laboratory technic of making the agents used is described. It seems complicated and difficult. Injections were intradermal, but an effort was made to plant the agents in the sinuses or in the middle meatus. Staphylococcus was found in all cases! As for the patients who had disease of the lungs, all showed a mixed infection. The tuberculous ones had "far advanced" disease and were "seemingly hopeless—nothing else could be done for them!" Of the 47, 1 who had bronchiectasis, did not improve. Two with allergic bronchitis and 6 with far-advanced pulmonary tuberculosis, "improved immensely." Of 16 patients who had sinusitis, 81.25 per cent were improved, but 18.75 per cent were unimproved. In discussion, Dr. Howard Westcott, New York,

called for testing of the procedures by others who have similar patients under their care. Skin tests offer no criterion of value of the treatment, since end results only should be decisive. Dr Edmonde D Neer, New York, referred to the late Dr Mackenty's results from surgical treatment of the sinuses, which were excellent. He praised bacteriophage, used locally, and spoke of its "destructive action" on staphylococci. He said, further, that nothing in the literature shows results comparable to the work of Kinghorn and his associates. "only the best laboratory facilities and the most patient investigators can duplicate these results"

Voorhees, New York

CONSERVATIVE AND SURGICAL MANAGEMENT OF ETHMOID AND SPHENOID SINUSITIS STUART L. CRAIG, New York State J Med 49 181 (Jan 15) 1949

Conservative treatment calls for (1) dietary considerations, (2) studies as to the supply of vitamins A, B (the complex), C (ascorbic acid) and D, as to environmental conditions and as to worry, fatigue, etc (3) correction of glandular dyscrasias, hypothyroidism and other endocrinopathies. Glandular preparations are best administered by an endocrinologist. For allergy plus bacterial invasion the physician has such drugs as diphenhydramine hydrochloride (benadryl hydrochloride®) and tripeleminamine hydrochloride (pyribenzamine hydrochloride®). Frequent colds in children may be due to obstructing adenoids, tonsils, polyp or deviated septum. Vaccines may be useful against resistant infections of known origin. For diagnosis roentgen study is imperative. Material should be taken from all infected sinuses and cultured. The procedure is outlined. Colon bacilli are often found in the sphenoid sinus! They are not susceptible to penicillin but succumb to streptomycin and sulfadiazine administered singly or in combination. Acute ethmoiditis yields to suction, irrigation, packs, aerosol penicillin, rest in bed, sedation and humidification. Inhalations of menthol, eucalyptus and camphor per formula are valued. Craig also uses a modified Proetz technic. Acute sphenoiditis is often unrecognized. It is suspect whenever pain in areas supplied by the fifth nerve are involved. Irrigations and nasal drops used at home are helpful. Chronic ethmoiditis rarely calls for ablation of the ethmoid labyrinth. Crusts and reinfections are common. The transantral approach does less damage, and the external route may be preferable. Radical operations are permissible in the presence of ocular complications with impending loss of vision. In any case postoperative care is paramount. Use the antibiotics, cauterize excess granulations.

Voorhees, New York

Miscellaneous

AN EPIDEMIC OF DIPHTHERIA WILLIAM A. REILLY, Am J Dis Child 74 130 (Aug) 1947

Reilly states that there has been a gradual loss of immunity in the United States since 1915, when prophylaxis against diphtheria was begun here. This report deals with 413 personnel of the Fifty-Ninth Evacuation Hospital in Palermo, Sicily, between August 1943 and May 1944. Eighty-one patients had active diphtheria, 116 were carrying virulent diphtheria bacilli but had a mixed infection, and 19 were "healthy carriers." It was difficult to differentiate the infection clinically from follicular tonsillitis or ordinary pharyngitis, for a membrane and toxicity developed in many cases. Patients with negative reactions to the Schick test numbered 13 (16 per cent) of 81 with active diphtheria, this number was higher than previous averages. There were no deaths, but myocarditis developed in 1 man. The frequency of the types of diphtheria organisms was in this order: gravis, mitis, intermedius, however, the mortality was extremely low. Sulfathiazole and sulfadiazine eradicated secondary organisms.

and made antitoxin more effective and possibly helped to remove the carrier condition. The duration of the membrane in persons with a positive Schick reaction following diphtheria averaged six and one-half days. The Schick test done within forty-eight hours after administration of 25,000 to 75,000 units of antitoxin gave negative reactions in all cases.

VOORHEES, New York

IMPORTANCE OF BRONCHIAL RUPTURE IN TUBERCULOSIS OF ENDOTHORACIC LYMPH NODES O GORGENYI-GOTTSCHE and D KASSAY, *Am J Dis Child* **74** 166 (August) 1947

The authors, from the St James and White Cross Hospitals, respectively, in Budapest, Hungary, studied bronchial rupture in 18 children by bronchoscopy and in 8 at autopsy. The percentage of rupture is much higher than hitherto published figures have shown. Ruptures in 52.6 per cent of cases were proved by bronchoscopy, many ruptures occur in the smaller tubes, which cannot be visualized. The prognosis is not so poor as one might think, for the process is one of relief in which debris and bacilli are coughed out. The bronchial rupture takes place four to six months after primary tuberculosis infection becomes manifest, in small babies, it may be earlier.

Prodromal signs are a "ringing brassy" cough, "bitonal" in sound, which is due to vibrating granulation tissue or caseous extrusions, and an "asthmatic wheeze." Constant fever, with a persistently high sedimentation rate, indicates that the impending rupture is due to the active tuberculous process of the lymph nodes, if fever occurs after the rupture, occlusion of a bronchus or bronchogenic spread is a likely cause. The diagnosis is aided by the Holzknecht-Jakobson sign (movement of the mediastinal organs on inspiration, observed during roentgenologic examination). Fourteen of fifteen ruptures were thus diagnosed. In any case, the sign is an imperative indication for bronchoscopy. Since bronchoscopy is a harmless procedure in infants and children, it is useful, not only in diagnosis, but in the removal of pulmonary masses, it may, therefore, be lifesaving. "Bronchoscopy," say the authors, "is an important procedure which cannot be spared in pediatric practice." The article is forty-one pages in length, it contains two tables and twelve roentgenograms.

VOORHEES, New York

APHASICS OBSERVATIONS AND TENTATIVE CONCLUSIONS JON EISENSON, *J Speech Disorders* **12** 290 (Sept) 1947

Examinations of persons with aphasia in Army hospitals showed no reliable correlation between the type of language dysfunction and the site of injury. Neither was there any consistent relation between the extent of brain injury and the capacity to relearn. The loss of capacity to abstract observed in civilians with aphasia was by no means a general characteristic of the behavior of most aphasic patients in the Army. An average or higher premorbid intelligence was more frequently associated with aphasia and with the maintenance of aphasic disturbances than was a below average intelligence. Premorbid personality traits are highly important factors. With regard to the site of the brain injury there was only one consistent finding. When aphasic disturbances continued to be present three or four months after the incidence of trauma, it was noticed that the injured area always involved part of the contralateral cerebral hemisphere. Except in cases in which the amount of brain injury was extremely great and involved both cerebral hemispheres, the extent of the injury seemed to have little bearing on the patient's progress and improvement. One patient had suffered approximately a 25 per cent loss of brain tissue in the left occipital and parietal areas. Despite this, he progressed from having almost global aphasia

called for testing of the procedures by others who have similar patients under their care. Skin tests offer no criterion of value of the treatment, since end results only should be decisive. Dr Edmonde D Neer, New York, referred to the late Dr Mackenty's results from surgical treatment of the sinuses, which were excellent. He praised bacteriophage, used locally, and spoke of its "destructive action" on staphylococci. He said, further, that nothing in the literature shows results comparable to the work of Kinghorn and his associates. "only the best laboratory facilities and the most patient investigators can duplicate these results"

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IMPORTANCE OF BRONCHIAL RUPTURE IN TUBERCULOSIS OF ENDOTHORACIC LYMPH NODES O. GORGENYI-GOTTSCHE and D. KASSAY, *Am J Dis Child* **74** 166 (August) 1947

The authors, from the St. James and White Cross Hospitals, respectively, in Budapest, Hungary, studied bronchial rupture in 18 children by bronchoscopy and in 8 at autopsy. The percentage of rupture is much higher than hitherto published figures have shown. Ruptures in 52.6 per cent of cases were proved by bronchoscopy, many ruptures occur in the smaller tubes, which cannot be visualized. The prognosis is not so poor as one might think, for the process is one of relief in which debris and bacilli are coughed out. The bronchial rupture takes place four to six months after primary tuberculosis infection becomes manifest, in small babies, it may be earlier.

Prodromal signs are a "ringing brassy" cough, "bitonal" in sound, which is due to vibrating granulation tissue or caseous extrusions, and an "asthmatoïd wheeze." Constant fever, with a persistently high sedimentation rate, indicates that the impending rupture is due to the active tuberculous process of the lymph nodes, if fever occurs after the rupture, occlusion of a bronchus or bronchogenic spread is a likely cause. The diagnosis is aided by the Holzknecht-Jakobson sign (movement of the mediastinal organs on inspiration, observed during roentgenologic examination). Fourteen of fifteen ruptures were thus diagnosed. In any case, the sign is an imperative indication for bronchoscopy. Since bronchoscopy is a harmless procedure in infants and children, it is useful, not only in diagnosis, but in the removal of pulmonary masses, it may, therefore, be lifesaving. "Bronchoscopy," say the authors, "is an important procedure which cannot be spared in pediatric practice." The article is forty-one pages in length, it contains two tables and twelve roentgenograms.

VOORHEES, New York

APHASICS: OBSERVATIONS AND TENTATIVE CONCLUSIONS JON EISENSON, *J Speech Disorders* **12** 290 (Sept) 1947

Examinations of persons with aphasia in Army hospitals showed no reliable correlation between the type of language dysfunction and the site of injury. Neither was there any consistent relation between the extent of brain injury and the capacity to relearn. The loss of capacity to abstract observed in civilians with aphasia was by no means a general characteristic of the behavior of most aphasic patients in the Army. An average or higher premorbid intelligence was more frequently associated with aphasia and with the maintenance of aphasic disturbances than was a below average intelligence. Premorbid personality traits are highly important factors. With regard to the site of the brain injury there was only one consistent finding. When aphasic disturbances continued to be present three or four months after the incidence of trauma, it was noticed that the injured area always involved part of the contralateral cerebral hemisphere. Except in cases in which the amount of brain injury was extremely great and involved both cerebral hemispheres, the extent of the injury seemed to have little bearing on the patient's progress and improvement. One patient had suffered approximately a 25 per cent loss of brain tissue in the left occipital and parietal areas. Despite this, he progressed from having almost global aphasia

to a point where he could speak with a fair degree of fluency, could write and copy from dictation and could read simple blueprints. In contrast, another patient, with comparatively little known brain injury in the left temporal area, had persistent and severe difficulties after more than a year of training. In 30 aphasic patients, only 2 showed any significant loss in the ability to abstract. Of 69 aphasic patients at two Army neurosurgical centers, the general classification scores showed that 55 were of average or better intelligence. Data on educational achievement tend to support this observation. A study of 64 patients showed that the majority were of the higher educational level. Subjectively, the author states that aphasic patients who showed severe expressive disturbances had for the most part been withdrawn persons prior to injury. The social service histories of the Red Cross tended to support this observation. The observations, the author states, are tentative.

M F PALMER, Wichita, Kan

SURVEY OF RAGWEED POLLINATION IN THE NEW YORK METROPOLITAN DISTRICT IN 1946 EUGENE H WALKER, JEROME SHERMAN, ROBERT A CHAIT and MATTHEW WALZER, New York State J Med 47 1979 (Sept 15) 1947

This study was made in the division of allergy, at the Jewish Hospital of Brooklyn, in collaboration with the pollen survey committee of the American Academy of Allergy. The standard technic recommended by the committee was used. In 1946, pollen counts were fairly low for an average of the five boroughs, the count in Manhattan was regarded as most representative. The counts at two stations in Connecticut used as a control were lower than for Greater New York, while those at Washington, D C, Philadelphia and Cleveland were higher. The peak for the season, at most stations, was on or about September 10. Ragweed pollen in 1946 came in late and was not heavy. In general, weather conditions, such as rain or fog, during the period from May through September affect the scattering of pollen, and, of course, the direction and velocity of winds always have a bearing on the distribution of pollen.

The authors conclude that the available data were insufficient for evaluation of the effect of the campaign carried on by the city authorities for the extermination of ragweed.

VOORHEES, New York

AN EVALUATION OF ANESTHESIA WITH PENTOTHAL-SODIUM, NITROUS OXIDE, AND ETHER PAUL W SEARLES, New York State J Med 47 2091 (Oct 1) 1947

Searles's investigations were begun in World War II and have been carried on at the University of Buffalo since his return. He states that he regards the sequence of thiopental sodium (pentothal sodium®), nitrous oxide and ether as nearly ideal, and states that the barbiturates tend to protect animal organisms against the toxicity of ether. The latter causes a concentration of the blood, and the barbiturates a dilution of the blood. Indications for the combination are operations on the chest and the abdomen, as well as minor procedures. Contraindications are a cardiac history, dyspnea, hepatic lesions, extreme youth or age and alcoholism. Patients with alcoholism may require an overdose, and prolonged postoperative depression may result. Complications are a fall in blood pressure, hiccups, coughing and laryngospasm, all of which can well be controlled by the experienced anesthetist.

The ideal general anesthetic should provide a wide margin of safety, adequate relaxation of the muscles, a quiet operative field, early, pleasant recovery and a minimum of postoperative complications. In Searles's opinion, thiopental sodium secures satisfactory induction and a quiet operative field. Nitrous oxide

plus oxygen sustains the effects mentioned, and ether supplements and prolongs the action of the other anesthetics. The average dose of thiopental sodium is small when used in this combination (from 0.7 to 1.0 Gm) and much of this is taken up during induction.

VOORHEES, New York

BRAIN TUMOR SIMULATING PURULENT MENINGITIS. EMANUEL APPELBAUM, JANE W. NORMAN and JOEL J. BRENNER, New York State J. Med. 47:2106 (Oct. 1) 1947.

A man of 55, was admitted to Bellevue Hospital with severe frontal and nuchal pain of two weeks' duration, stupor and slow cerebration. Nothing abnormal was noted in the examination of the ears, nose and throat. There were bradycardia, slight left facial paresis and positive Brudzinski and Kernig signs. On the fifth day, ophthalmoscopic examination showed engorgement of the vessels and bilateral papilledema. The spinal fluid was full of cells "too numerous to count" (chiefly polymorphonuclear leukocytes), but there were no bacteria. Encephalograms were made, and craniotomy was done on the right temporal lobe. After the operation a slight gain was noted, but the patient soon died. A brain abscess had been suspected, but the actual lesion was a brain tumor. The authors conclude that meningitis sympathica may confuse a diagnosis, particularly when the meningeal condition is pronounced. The condition occurs with brain abscess and with inflammation of the sinuses or the mastoid. The spinal fluid is increased, is hazy to turbid and contains many polymorphonuclear leukocytes and much protein, but the blood sugar is normal, and there are no organisms. Repeated examinations of the spinal fluid may be necessary to assure that the condition is not a delayed bacterial invasion. The authors note the similarities of brain tumor and meningitis as to symptoms. Fever and nuchal rigidity may even appear with cerebral neoplasm, and, rarely, the spinal fluid may become purulent. In this case, the pathologist reported spongioblastoma multiforme, which the authors say may show rapid growth and progressive necrosis. The problem of diagnosis is presented in detail, the prognosis is, of course, uniformly bad.

VOORHEES, New York

INTRAVENOUS PROCAINE. A PRELIMINARY REPORT. DAVID J. GRAUBARD, RAPHAEL W. ROBERTAZZI and MILTON C. PETERSON, New York State J. Med. 47:2187 (Oct. 15) 1947.

These studies were undertaken in the anesthesia division of the Reconstruction Hospital Unit, New York Post-Graduate Medical School and Hospital, and reported to the New York state medical society at its meeting in Buffalo, May 7, 1947. Procaine hydrochloride is a toxic drug, and its toxicity is increased when it is used with epinephrine. The authors wished to relieve pain in traumatic and inflammatory conditions. Over 2,000 intravenous infusions of procaine hydrochloride were given with no serious effects. Indications were fractures, traumatic arthritis, the neuritides, congenital spasticity and several other disorders. Reactions were general body warmth, flushing of the head, face and neck, oral dryness, metallic taste, dilatation of the pupils, slight vertigo, general relaxation of the body and alleviation of pain. No permanent results were noted in spinal sclerosis, but there were decreased spasticity, increased coordination and relief of "cold sensations" in poliomyelitis.

Dr. Maurice Bruger, discussing this study, states that sedimentation rates and chemical examinations were made before and during the procaine therapy in 5 cases, but no changes indicating any deleterious effects were observed in the blood or urine. Bruger states "Procaine administered intravenously twice weekly over

a period of one month in the doses indicated has no measurable effect on renal or hepatic function, sugar or cholesterol content of the blood or the rate of sedimentation" A 0.1 per cent solution in isotonic sodium chloride solution was used. One cubic centimeter contained 1 mg of procaine hydrochloride.

Voorhees, New York

MEDICAL CONSIDERATION OF THE AIR TRAVELER FREDERICK HOPKINS SHILLITO,
New York State J Med 47 2201 (Oct 15) 1947

No persisting deleterious effects on the general body economy or on the special sense organs are to be observed under present day conditions of air travel in comparison with earlier days, says Dr Shillito. Pressurization of the cabin is probably the most important advance, it is now possible to have sea level cabin pressure at 18,000 feet (5,486 M). The passenger is made comfortable in well upholstered chairs and is served good, hot meals.

As to conditions involving the ears, nose and throat, perforation of the drum is of no concern, but a recently healed perforation may reopen under too abrupt atmospheric change. Infected sinuses may empty on ascent, and the ostiums may close on descent, giving rise to some discomfort. Aerodontalgia (pain in the teeth) does occur. Nasoconstrictor drops are recommended before descent. Either the Politzer or the Valsalva maneuver may be employed to inflate the tubes.

Moderate anemia and cardiac or pulmonary lesions usually are not contraindications for flying. Babies tolerate air travel well. However, there is the possibility of transmitting tropical and other contagious or infectious conditions from one country to another.

Voorhees, New York

ESCHERICHIA COLI MENINGITIS TREATED WITH STREPTOMYCIN HYMAN LIEBERMAN,
New York State J Med 47 2206 (Oct 15) 1947

This is a rare but usually fatal form of meningitis. In infants under 3 months, this form comprises 30 to 50 per cent of all cases. In older groups, it accounts for 1 case in 300 to 700 (0.3 to 0.14 per cent).

"With the advent of streptomycin," states the author, "the outlook in the treatment of the meningitides due to gram-negative organisms has become considerably brighter." Alexander reported the case of a soldier of 19, wounded in action. Osteomyelitis of the tibia, Escherichia coli bacteremia and Esch coli meningitis developed. The patient recovered after receiving 18,275,000 units of streptomycin intramuscularly for eleven days, plus 650,000 units intrathecally in thirteen injections. Shields reported recovery in the case of an infant of 5 weeks, whose blood and spinal fluid both contained pure Esch coli communior. The dosage was 2,630,000 units of streptomycin intramuscularly (30,000 units every three hours for ten days) and 300,000 units intrathecally (30,000 units into the basal cistern daily for ten days). The authors in each case felt that the recovery was due to streptomycin. Lieberman's case was that of a girl of 9 months, who had a normal birth at term, weighing 8 pounds 3 ounces (3,714 Gm). The diagnosis was made clinically and by culture of the spinal fluid, which showed Esch coli communior. Large doses of streptomycin were given intramuscularly and intrathecally. Clinical recovery, "somewhat unusual in this type of meningitis," occurred on the sixth day. Because of the falling hemoglobin content, a transfusion of citrated whole blood was given. The total dose of streptomycin was 200,000 micrograms into the spinal canal and 3,400,000 units into the muscles.

Voorhees, New York

News and Comment

THIRD ANNUAL CLINICAL SESSION OF THE AMERICAN MEDICAL ASSOCIATION

The Third Annual Clinical Session of the American Medical Association will be held in Washington, D C, December 6 to 9

The Clinical Session will provide a full scale scientific program specifically designed for the general practitioner Outstanding physicians will discuss such subjects as diabetes, pediatrics, laboratory diagnosis, physical medicine and rehabilitation, arthritis, dermatology, roentgen ray diagnosis, cancer and poliomyelitis Coordinated with this outstanding scientific program will be approximately one hundred scientific exhibits which will present original work on the subjects discussed

The newest offerings of one hundred and twenty-five manufacturing firms will comprise the Technical Exhibition Here will be found the latest developments in scientific medical research, drugs and equipment

Televised surgical and clinical procedures, similar to those shown in color at the Annual Session of the American Medical Association in Atlantic City last June, will be presented at the Washington meeting The demonstrations will originate in the Johns Hopkins Hospital and will be shown on screens in the Armory The television schedule will be spread over four days

The House of Delegates will meet at the Hotel Statler during this session One of the first orders of business will be the annual selection of the general practitioner who has made an exceptional contribution of service to his community

An entertainment program is being planned for attending physicians and their wives The highlight of this program will be on Wednesday evening, December 7, when the Philip Morris Company will originate its "This Is Your Life" broadcast from the Hotel Statler The radio program will be followed by a stage show, in which outstanding stars will participate

Blanks for hotel reservations and advance registrations may be found in *The Journal of the American Medical Association*

SECOND PAN-AMERICAN CONGRESS OF OTORHINOLARYNGOLOGY AND BRONCHESOPHAGOLOGY

The Second Pan-American Congress of Otorhinolaryngology and Bronchoesophagology will take place on Jan 8 to 15, 1950, in Montevideo and Buenos Aires

Dr Justo M Alonso is president of the congress, Dr Elias Regules, Dr Juan C Munyo and Dr Juan C Oreggia are vice presidents, and Dr Pedro Regules is general secretary Delegates to the executive committee include Dr Ricardo Tapia Acuña, of Mexico, D F, and Dr Chevalier L Jackson, of 3401 North Broad Street, Philadelphia Further information may be obtained from Dr Pedro Regules by calling San Jose 1092, Montevideo, Uruguay, or from a delegate of the executive committee

OTOLARYNGOLOGICAL SOCIETY OF ISRAEL

The Otolaryngological Society of Israel was recently founded, with Dr Sherman, of Tel-Aviv, as its president. In Israel there are about one hundred ear, nose and throat specialists, from nearly all the countries of the world. The first meeting of the society will be held in Tel-Aviv during the second half of December 1949. The subjects to be discussed at this meeting are the social approach to the problem of deafness and new views on the vestibular apparatus. All colleagues from abroad who wish to participate in the meeting should notify the honorary secretary, Dr E. Wodak, 9 Javneh Street, Tel-Aviv, Israel, as soon as possible.

Book Reviews

Traitement chirurgical de l'otospongiose By Maurice Sourdille Price, 750 francs Pp 254, with 52 illustrations Paris Masson et Cie, 1948

This book deals with the work Sourdille has originated and performed over the course of the last twenty years for the surgical treatment of progressive deafness in clinical otosclerosis. He treats this condition with a properly placed labyrinthine fistula which remains sensitive to very slight variations in sound pressures.

Historical data are given on the progressive development of this surgical procedure, on both the experimental and the operative technic. The entire problem of improvement of hearing by labyrinthine operation is presented. It is interesting to note the author's interest in this surgical approach and his early prediction that the surgical steps would be simplified into a one step operation. The historical sequence of the development of surgical relief from deafness is also presented.

The original operative procedures of Barany, Jenkins, Holmgren, Wittmaack and others are presented and their respective contributions and improvements described.

Sourdille's original presentation on this subject in 1929 is included when he reports his findings and results of his initial surgical endeavors, which were stimulated by his contacts with Holmgren and Barany in 1924. Also discussed is the surgical development, step by step, by others interested in this work, as well as his own contributions, such as the tympanomeatal plastic flap. The experimental basis and the physioacoustic problems, with the mechanisms involved, such as the role of the head of the malleus, the role of the incus, the functional role of the plastic flap and other factors, are dealt with at length.

Discussion of armamentarium, instrumentation and operative technics is brought up to present day practices and procedures. Postoperative care and complications are clearly discussed.

The author concludes by stating that after his experience of more than twenty years, he firmly believes that the progression of deafness by otosclerosis is definitely retarded or arrested by a properly placed labyrinthine fistula which remains sensitive to very slight variations of pressure. Moreover, the labyrinthine fistula has demonstrated at times a pronounced improvement which is lasting and permanent. The "noli-me-tangere" attitude must now give way to acceptance of this surgical approach, which is withstanding the test of time.

Diseases of the Nose and Throat Fifth edition By Sir St Clair Thomson and V E Negus Price, \$16 Pp 1,024 New York Appleton-Century-Crofts, Inc, 1949

The original of this new edition, was described by Chevalier Jackson as "the greatest book on the nose and throat ever published." This edition was started during the adverse circumstances produced in England by the war, and its renowned author, Sir St Clair Thomson, was about 80 years old when he began the revision. Unfortunately, after working on the book several years, he met with an accident, and much of the work of completing the volume fell to V E Negus.

Great maturity of thought and experience is reflected in the material. Major alterations have been made in the revision and recent publications and developments included. Emphasis is placed on physiology, so well investigated by Proetz, less emphasis is placed on the many conditions that are rapidly declining in frequency because of the new methods of treatment. A new chapter on antibiotics, chemotherapy and vitamins is included. Much of the older material is reevaluated in terms of the newer concepts. An excellent chapter is presented on diseases and neoplasms of the nasopharynx, pharynx and larynx. The entire book is organized to present the specific subject and its relation to general principles of medicine and surgery. Many of the narrow limits of specialties are broken down. The relation of systemic diseases, especially blood diseases, to those of the nose and throat is greatly amplified.

The book contains about 1,000 pages and about 60 pages of excellent index. Each chapter is followed by an exceptionally comprehensive bibliography, which is invaluable in investigating the subject. Operative procedures are described in adequate detail. Many of the illustrations are original and give fine orientation to the word descriptions. This new edition is a tribute to the memory of its eminent author and should be used by all rhinolaryngologists.

Treatment of Primary Malignant Tumors of the Maxilla (in French) By Marcel Dargent, Marcel Gignoux and Jean Gaillard. Price, 500 francs. Pp 216, with 39 illustrations. Paris: Masson & Cie, 1948.

This book is a result of combined work of the tumor center and the department of otolaryngology of the University of Lyons, France. It comprises seven chapters, dealing, respectively, with anatomy, pathology, initial symptomatology, evolution, diagnosis, results of treatment and indications for treatment.

The authors report on 16 cases of sarcoma and 191 cases of epithelioma. The majority of the sarcomas (13) were osteogenic. Of the epitheliomas 44 were of the palate and gum, 43, of anterior localization, with bulging of the cheek, 35 encroached toward the orbit and the ethmoid bone, and 61 showed invasion in all directions. Secondary involvement of the lymph nodes was frequent in the region of the submaxillary gland and the carotid artery (70 cases).

In addition to the regular roentgenographic findings, lateral exposures give useful information about the infiltration of the inferior (palatine) type of tumors.

The authors give preference to total or partial resection of the maxilla, followed by roentgen irradiation or radium treatment and, if indicated, removal of the involved lymph nodes. The treatment with roentgen radiation lasts five to six weeks, with a daily dose of 200 to 300 r in two separate sittings. The radium treatment consists in use of molded apparatus eight hours daily for four to seven days. The authors do not favor electrocoagulation. Forty deaths occurred during the first year, 45 patients were living after two years, and 24 patients were living after five years.

The book is well illustrated with photographs of patients and roentgenograms.

A Contribution to the Study of the Surgical Approach to the Attic (in French) By J. Barny de Romanet, M.D. Price not stated. Paris: R. Foulon, 1947.

The author presents the historical development of the postauricular and endaural approaches to the mastoid process. The various incisions for these approaches are described in detail and the advantages and disadvantages of each enumerated.

Romanet believes that the endaural approach is the most advantageous and that there are no real contraindications to it. The main and only real disadvantage is that this approach requires complete surgical competence for complications ensue if it is poorly executed.

In the fenestration operation, if the malleus is to be preserved, as advocated by Sourdille, the postauricular approach is practically imperative.

Whenever the lesion is located in the attic, and in the attic only, the technic of Thies is advocated.

The subject is well presented, and the book is concise and contains a good outline of the various surgical approaches to the mastoid.

Zinc Ions in Ear, Nose and Throat Work By A R Friel Price, \$2 Pp 59, with illustrations Bristol, England John Wright & Sons, Ltd, 1948

This belated booklet represents the compilation of the experience of a few British enthusiasts on the value of ionization. The first forty pages, over two thirds of the book, give generalities about the use of direct current in medicine, its physiologic effects and the equipment needed for this type of electric therapy.

Considerable stress is laid on the value of the treatment in chronic otorrhea, as practiced by Mr A G Wells, F R C S, in the school clinics of the London County Council. (In 1929 the reviewer observed the extraordinary results that were obtained by Wells and confirmed the work on his return to the United States. Friel gives the technic for treating various kinds of aural infection—with granulations, with different types of perforation, with eczema, etc. The last part of the book is devoted to electrolysis of the turbinate bodies, sinuses and tonsils.

The approach to the subject is direct, thorough and clear. It would have been an advantage if more clinical evidence had been included to support the claims to the value of electrolysis, ionization and coagulation. It would also have been well if more modern and more convenient circuits had been described for the utilization of direct current.

CORRECTION

In the article by Dr James M Evans, "Role of Compensatory Hypertrophy and Simple Atrophy in Intranasal Surgery," in the August issue of the ARCHIVES, page 172, the illustration on page 174 should be in the top position of page 176 and the figure in top position on page 176 should be on page 174.

Directory of Otolaryngologic Societies *

INTERNATIONAL

FOURTH INTERNATIONAL CONGRESS OF OTOLARYNGOLOGY

President Dr V E Negus, London, England
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Place London Time July 18-23, 1949

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President Prof Justo Alonso
Secretary Dr Chevalier L Jackson, 255 S 17th St, Philadelphia 3
Place Montevideo Time January 1950

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON LARYNGOLOGY, OTOLOGY AND RHINOLOGY

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Secretary Dr C Stewart Nash, 708 Medical Arts Bldg, Rochester 7, N Y

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* Secretaries of societies are requested to furnish the information necessary to keep this list up to date

ACTIVE IMMUNIZATION AGAINST SECONDARY BACTERIAL INFECTIONS OF THE COMMON COLD

I Acquired Immunity in Mice Following Oral and Intra-Abdominal Administration of Stock Polyvalent Bacterial Vaccines

JOHN A. KOLMER, M.D.

With the Technical Assistance of Anna M. Rule

PHILADELPHIA

MOST investigators now regard a virus as the cause of the common cold. This primary infection, however, is usually followed within a few days by a secondary bacterial or purulent infection, which not only prolongs the disease but is largely responsible for such complications as sinusitis, pharyngitis, laryngitis, otitis media, tracheobronchitis and pneumonia.

This important secondary infection is due not to any specific bacterium but to one or more of the bacterial species commonly occurring in the upper respiratory tract. In a recent investigation of this phase of the disease, Kolmer, Bondi and Schillinger¹ found that beta hemolytic streptococci of group A, *Staphylococcus aureus* and various pneumococci (especially *Diplococcus pneumoniae* of types III, VI, X, XI and XIX) occurred most frequently, although streptococci of the viridans group, gamma streptococci, *Staphylococcus albus*, *Hemophilus influenzae*, *Klebsiella pneumoniae* and organisms of genus *Neisseria* (especially *Neisseria catarrhalis*) were found frequently enough to be of additional etiologic significance in some cases.

No attempts have been made up to the present time in active immunization or vaccination of human beings against the virus of the common cold. But, in view of the clinical importance of the secondary bacterial infections of the disease, many investigators have sought to determine whether or not the administration of polyvalent bacterial vaccines possesses prophylactic value against them. My experience has been largely confined to the preparation and administration of

From the Research Institute of Cutaneous Medicine.

This investigation was aided by a grant from The Wm. S. Merrell Company, Cincinnati.

1. Kolmer, J. A., Bondi, A., Jr., and Schillinger, C. A Study of the Bacterial Flora of the Nasopharynx in Relation to the Common Cold, *Arch. Otolaryng.* 47: 571 (May) 1948.

mixed autogenous vaccines by subcutaneous injection Since 1929 these have been administered during September or October in gradually increasing doses, at weekly intervals, for four weeks in succession, followed by a "booster" dose once a month to May or June² Favorable results have been observed in from 60 to 80 per cent of cases without chronic suppurative sinusitis, consisting in the apparent escape from common colds or the occurrence of but mild attacks limited to a few days without clinically manifest secondary bacterial infections and their complications

A large and controversial literature, however, has accumulated on the efficacy of stock polyvalent vaccines of desiccated organisms and their soluble products by oral administration in the prophylaxis of the secondary bacterial infections This involves not only the question of vaccines escaping destruction in the gastrointestinal tract but the absorption of sufficient amounts of the dead organisms or their soluble antigenic substances for the production of effective degrees of immunity

From the standpoint of oral immunization in the prophylaxis of experimental infections of the lower animals, especially encouraging results have been reported with pneumococci Thus Ross³ has shown that rats may be rendered resistant to subcutaneous and intra-abdominal inoculations of 1,000 to 10,000 minimal lethal doses of types I, II and III pneumococci by the oral administration of tissues containing virulent organisms and by vaccines composed of heat-killed, acid-killed, bile-dissolved, desiccated and mechanically disrupted pneumococci and their soluble specific substances Ross⁴ has also found protective antibodies

2 Kolmer, J A Vaccination Against the Common Cold, *Arch Pediat* **46** 41 (Jan) 1929

3 Ross, V Immunity to *Pneumococcus* Produced in Rats by Feeding Tissues of Animals Killed by the Same Organism, *J Immunol* **12** 219 (Sept) 1926, Immunity to *Pneumococcus* Produced in Rats by Feeding Them the Germ, *ibid* **12** 237 (Sept) 1926, Immunization of Rats Against *Pneumococcus* by Feeding the Acid-Killed Germs and the Influence of the Age of the Animal Thereon, *J Lab & Clin Med* **12** 566 (March) 1927, Oral Immunization Against the *Pneumococcus* Use of Bile Salt Dissolved Organisms, etc, Time of Appearance of Immunity and Dosage, *J Exper Med* **51** 585 (April) 1930, Oral Immunization Against *Pneumococcus* Types II and III and the Normal Variation in Resistance to These Types Among Rats, *ibid* **54** 875 (Dec) 1931, The Rôle of the Soluble Specific Substance in Oral Immunization Against *Pneumococcus* Type I, *ibid* **54** 899 (Dec) 1931, The Rôle of the Soluble Specific Substance in Oral Immunization Against *Pneumococcus* Types II and III, *ibid* **55** 1 (Jan) 1932

4 Ross, V Protective Antibodies Following Oral Administration of *Pneumococcus* Type I to Rats, *J Immunol* **27** 249 (Sept) 1934, Protective Antibodies Following Oral Administration of *Pneumococcus* Types 2 and 3 to Rats, with Some Data for Types 4, 5 and 6, *ibid* **27** 273 (Sept) 1934

in the blood of rats following the oral administration of some of these vaccines, especially those for types I, II, III, IV and V pneumococci Kimura⁵ has reported that the oral administration to mice of vaccines of heat-killed pneumococci of type I engendered immunity in some animals, while Kolmer and Amano⁶ have observed that the oral administration to rabbits of vaccines prepared of types I, II and III pneumococci and hemolytic streptococci protected some animals against meningitis following intracisternal and intratympanic inoculations with virulent cultures of these organisms. We⁷ have also found that the oral administration of vaccines prepared from types I, II and III pneumococci may protect monkeys and rabbits against septicemia and pneumonia following intratracheal inoculations of virulent cultures and, likewise, protect against local pneumococcus infections following intradermal inoculations of virulent cultures.⁸

Much less investigation, however, has been devoted to the oral immunization of the lower animals against other organisms. Winzeler⁹ has reported that guinea pigs could be protected against virulent *Staph aureus* by the feeding of living organisms less effectively protected by the oral administration of heat-killed vaccines, the oral administration of both living and dead hemolytic streptococci, however, was found much less protective.

PURPOSE OF INVESTIGATION AND METHODS EMPLOYED

In the circumstances, we have thought it advisable to determine whether or not the oral and intra-abdominal administration of polyvalent stock vaccines, proposed for immunization against the secondary bacterial infections of the common cold, is capable of producing resistance or

5 Kimura, R. Weitere Versuche über aktive Immunisierung per os gegen Pneumokokken, *Ztschr f Hyg u Infektionskr* **107** 390 (April) 1927.

6 Kolmer, J. A., and Amano, K. W. The Specific Prophylaxis of Pneumococcus and of Streptococcus Meningitis, *Arch Otolaryng*, **15** 547 (April) 1932.

7 Kolmer, J. A., and Rule, A. M. Vaccination of Monkeys Against Pneumococci with Special Reference to Oral Immunization, *Proc Soc Exper Biol & Med* **31** 243 (Nov) 1933, Oral Immunization of Rabbits Against Pneumococcus Pneumonia and Septicemia, *ibid* **30** 107 (Oct) 1932, Vaccination of Rabbits Against Pneumococci with Special Reference to Oral Immunization, *ibid* **31** 245 (Nov) 1933.

8 Kolmer, J. A., and Rule, A. M. Vaccination of Rabbits Against Intradermal Pneumococcus Infection, *Proc Soc Exper Biol & Med* **32** 86 (Oct) 1934.

9 Winzeler, H. Experimentelle Untersuchungen über orale Immunisierung mit virulenten Staphylokokken und Streptokokken, *Ztschr f Immunitätsforsch u exper Therap* **77** 60 (July) 1932.

immunity in mice, even though destruction and absorption of vaccines in the gastrointestinal tract of these animals may be different from that in human beings

These investigations were conducted over a period of three years. The basic vaccine employed¹⁰ was prepared from *D pneumoniae*, hemolytic streptococci (group A), streptococci of the viridans group (respiratory tract), staphylococci, *H influenzae* (type A), *K pneumoniae* (type A), *N catarrhalis* and the concentrated supernatant broth of each bacterium.

Variations of this basic formula were also employed so as to increase the numbers of organisms present and the range of pneumococci and streptococci. Several of these formulas were based on the results of bacteriologic examinations of the nasopharynx by Kolmer, Bondi and Schillinger¹ in cases of the common cold. Placebo tablets were also administered as controls in all experiments.

The oravax[®] and placebo tablets were ground into very fine powders and 100 suspensions in sterile saline solution prepared of each. These suspensions were kept in a refrigerator and thoroughly shaken before administration to fasting mice (18 to 24 Gm) in doses of 0.5 cc by stomach once a day for ten days in succession. Mice were also given 0.5 cc by intra-abdominal injection once a day for ten days in succession.

Protection tests for acquired immunity were conducted fourteen days after the last dose of the vaccines and placebo. The challenging organisms were selected on the basis of their adaptability to mouse protection tests and consisted of hemolytic streptococci (group A), types I, II and III pneumococci and *K pneumoniae* (type A) by intra-abdominal inoculation and *Staphylococcus aureus* by intravenous injection. The virulence of each culture for mice by these routes of administration was determined just before the protection tests were conducted. In the latter each challenging organism was used in approximately 2 minimal lethal doses. Normal control mice were inoculated at the same time in each experiment as culture controls. All inoculated mice were kept under observation for ten days. Cultures of heart blood were made on moribund and most dying mice, and almost all gave positive cultures indicative of septicemic infections.

RESULTS

Since the results observed in the production of immunity by the basic vaccine and by modifications of it were essentially similar, they have been grouped and summarized as shown in the table.

10 Enteric-coated tablets of oravax (improved)[®] supplied by The Wm S Merrell Company, Cincinnati. Each tablet contains

	Million Cells	Concentrated Supernatant Broth from Million Cells
<i>D pneumoniae</i> (type I)	5,000	750
<i>D pneumoniae</i> (type II)	5,000	750
<i>D pneumoniae</i> (type III)	5,000	750
<i>D pneumoniae</i> (type VII)	5,000	750
<i>D pneumoniae</i> (type VIII)	5,000	750
<i>Str hemolyticus</i> (group A)	10,000	1,500
<i>Str viridans</i>	5,000	750
<i>H influenzae</i> (type A)	2,500	375
<i>N catarrhalis</i>	2,500	None
<i>K pneumoniae</i> (type A)	5,000	750
<i>Staph aureus</i>	5,000	750
<i>Staph albus</i>	5,000	750

It will be observed that about 63 per cent of normal control mice inoculated with approximately 2 minimum lethal doses of hemolytic streptococci survived as, likewise, 25 per cent of mice inoculated with *Staph aureus*. However, all control mice inoculated with types I, II and III pneumococci and with *Kleb pneumoniae* (type A) died. It will also be observed that the oral and intra-abdominal administration of the placebo tablets gave no evidence of engendering immunity against any of the six challenging organisms. Significant degrees of immunity or resistance, however, were observed in mice given the vaccines by oral and intra-abdominal administration, especially against hemolytic streptococci, types I and II pneumococci and *Staph aureus*. The same was true, but to a less extent, in the case of pneumococci type III and *K pneumoniae* (type A). Although the immunity or resistance against

Acquired Immunity in Mice Following the Oral and Intra-abdominal Administration of Stock Polyvalent Bacterial Vaccines and Placebo

Challenging Organisms*	Vaccines†		Placebo†		Culture Controls†
	Oral	Intra abdominal	Oral	Intra abdominal	
Str hemolyticus (group A)	28/60 46 6%	34/60 56 6%	0/12 0%	0/12 0%	2/32 6 3%
D pneumoniae (type I)	22/60 36 6%	32/60 53 3%	0/12 0%	0/12 0%	0/32 0%
D pneumoniae (type II)	8/20 40%	9/20 45%	0/12 0%	0/12 0%	0/24 0%
D pneumoniae (type III)	3/12 25%	5/12 41 6%	0/4 0%	0/4 0%	0/16 0%
K pneumoniae (type A)	13/32 25%	21/32 40 4%	0/12 0%	0/12 0%	0/32 0%
Staph aureus	9/16 56 3%	12/16 75%	1/8 12 5%	1/8 12 5%	2/8 25%

* Two minimum lethal doses of each culture by intra abdominal inoculation, except in the case of *Staph aureus*, which was injected intravenously

† Number of surviving mice over total number inoculated, with percentages of survivals

these organisms resulting from intra-abdominal administration appears to be greater in mice than that following oral administration, an analysis of the data by the chi square method indicates no statistically significant difference.

In the circumstances it appears, therefore, that stock polyvalent vaccines of the desiccated organisms and their soluble products commonly involved in the production of the secondary bacterial infections of the common cold are absorbed from the gastrointestinal tracts of an encouraging percentage of normal adult mice, with the production of immunity or resistance against the virulent organisms employed in this investigation. In this connection it also is to be stated that the 2 minimal lethal doses of each challenging organism employed were highly critical, since the results have been evaluated on the basis of mortality rather than on morbidity rates.

SUMMARY

The results of a study of acquired immunity in mice following the oral and intra-abdominal administration of tablets of stock polyvalent vaccines prepared of the desiccated organisms and their soluble products commonly involved in the etiology of the secondary bacterial infections of the common cold, are presented and discussed

Active immunity against hemolytic streptococci, types I, II and III pneumococci, *K pneumoniae* (type A) and *Staph aureus* was produced by the vaccines in a significant number of mice by both routes of administration

Immunity against the challenging organisms was not produced by the oral and intra-abdominal administration of placebo tablets

ACTIVE IMMUNIZATION AGAINST SECONDARY BACTERIAL INFECTIONS OF THE COMMON COLD

II Production of Protective Antibodies in Human Adults by the Oral Administration of Stock Polyvalent Bacterial Vaccines

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AS PREVIOUSLY reported,¹ the oral administration to mice of stock polyvalent vaccines prepared from the desiccated organisms and their soluble products commonly involved in the secondary bacterial infections of the common cold has been found effective in the active immunization of some of these animals against virulent hemolytic streptococci, pneumococci of types I, II and III, *Klebsiella pneumoniae* and *Staphylococcus aureus*. The investigations of Thomson and Thomson² have also shown that such vaccines may be absorbed after oral administration to human beings, in whom agglutinins are then produced. Ross³ has likewise found that the oral administration of vaccines of pneumococci to human beings not only is well borne but quickly produces immunity, since protective antibodies against the type I pneumococcus

This investigation was aided by a grant from the Wm. S. Merrell Company, Cincinnati, Ohio.

The present address of Dr. Bondi and Miss Schillinger is Hahnemann Medical College, Philadelphia.

From the Department of Bacteriology and Immunology of Temple University School of Medicine and the Research Institute of Cutaneous Medicine.

1 Kolmer, J. A. Active Immunization Against Secondary Bacterial Infections of the Common Cold. I. Acquired Immunity in Mice Following the Oral and Intra-Abdominal Administration of Stock Polyvalent Bacterial Vaccines, *Arch. Otolaryng.*, this issue, p. 687.

2 Thomson, D. Thomson, R., and Morrison, J. T. Oral Vaccines and Immunization by Other Unusual Routes, Baltimore, Williams & Wilkins Company, 1948.

3 Ross, V. Oral Immunization Against the Pneumococcus. Use of Bile Salt Dissolved Organisms, etc., Time of Appearance of Immunity and Dosage, *J. Exper. Med.* **51** 585 (April) 1930, Oral Immunization of Humans Against the Pneumococcus, *J. Immunol.* **27** 307 (Sept.) 1934.

were found in the serums of 75 per cent of subjects and against types II and III pneumococci in the serums of about 60 per cent Thomson and Thomson⁴ found that some agglutinins and protective antibodies were also produced in a few volunteers by the oral administration of a phenol-killed vaccine prepared from *Hemophilus influenzae* grown symbiotically with *Anaeromyces bronchitica*

PURPOSE OF INVESTIGATION AND METHODS EMPLOYED

In the circumstances we have thought it advisable to determine whether or not the oral administration of stock polyvalent bacterial vaccines to adult human beings is capable of producing protective antibodies against various virulent challenging organisms in mouse serum protection tests

These investigations were conducted over a period of three years The basic vaccine employed⁵ was prepared from *Diplococcus pneumoniae*, hemolytic streptococci of group A, streptococci of the viridans group (respiratory tract), H influenzae (type A), K pneumoniae (type A), *Neisseria catarrhalis*, staphylococci and the concentrated supernatant broth of each bacterium

Variations of this basic formula were also employed in such a way as to increase the numbers of organisms present and the range of pneumococci and streptococci Several of these formulas were based on the results of bacteriologic examinations of the nasopharynx by Kolmer, Bondi and Schillinger⁶ in cases of the common cold Placebo tablets were also administered as controls in all experiments

4 Thomson, D, Thomson, R, and Thomson, E T Immunization by the Oral Route in Respiratory Tract Infections, with Special Reference to Influenza Colds, and Their Complications, *Brit M J* 1 258 (Feb 8) 1936

5 Enteric-coated tablets of oravax[®] (improved) were supplied by The Wm S Merrell Company, Cincinnati

	Cells Millions	Concentrated Supernatant Broth from Million Cells
D pneumoniae (type I)	5,000	750
D pneumoniae (type II)	5,000	750
D pneumoniae (type III)	5 000	750
D pneumoniae (type VII)	5,000	750
D pneumoniae (type VIII)	5,000	750
Str hemolyticus (group A)	10,000	1,500
Str viridans	5 000	750
H influenzae (type A)	2 500	375
N catarrhalis	2,500	None
K pneumoniae (type A)	5,000	750
Staph aureus	5,000	750
Staph albus	5,000	750

6 Kolmer, J A, Bondi, A, Jr, and Schillinger, C A Study of the Bacterial Flora of the Nasopharynx in Relation to the Common Cold, *Arch Otolaryng* 47 571 (May) 1948

Enteric-coated tablets of the vaccines were administered to 116 and the placebo tablets to 35 selected medical students, totaling 151 normal adults. The vaccines were administered according to various dosage scales as follows: (1) 1 tablet a day for seven days in succession followed by 2 tablets a week for a total of 50 tablets, (2) 1 tablet twice daily for fourteen days in succession, followed by 1 tablet three times a week for a total of 50 tablets, (3) 1 tablet three times a day for seven days in succession, followed by 1 tablet twice weekly for a total of 50 tablets, (4) 2 tablets twice daily for seven days in succession, followed by 4 tablets a week for a total of about 100 tablets, (5) 1 tablet a day for sixty days in succession, followed by 3 tablets a week for a total of about 100 tablets, (6) 1 tablet a day for seven days in succession, followed by 2 tablets per week for a total of about 60 tablets, and (7) 1 tablet a day for a total of about 140 tablets. The placebo tablets were administered according to schedules 1, 4 and 5.

Specimens of blood were collected aseptically from each subject before the administration of the tablets of vaccines and placebo and the serums retained under deep freeze until needed for serum protection tests. Specimens of blood were again collected aseptically two to three weeks after all the oravax® and placebo tablets had been taken and the serums kept under deep freeze for about a month, when the mouse serum protection tests were conducted. On the completion of these tests each subject whose serum showed the presence of protective antibodies against a challenging organism was retested with serum collected before the administration of the tablets for the detection of possible natural antibodies. This policy was adopted for reasons of economy and on the assumption that the serum of a subject showing no protective antibodies after the administration of a vaccine or the placebo was not likely to show their presence in serum collected before administration.

The challenging organisms selected were those best adapted for mouse serum protection tests, embracing virulent beta hemolytic streptococci of group A, pneumococci type I and K pneumoniae (type A). The virulence of each culture for mice (weighing 18 to 24 Gm) by intra-abdominal inoculation was determined and each employed in a dose of approximately 2 minimum lethal doses in the serum protection tests. In the latter, each of 4 to 6 mice was given an intra-abdominal injection of a mixture of 0.1 cc of serum and 0.1 cc of culture so diluted as to contain approximately 2 minimum lethal doses. In each experiment normal control mice were inoculated intra-abdominally with the same dose of each organism as culture controls. All mice were kept under observation for eight to ten days, when the results were evaluated on the basis of survival over this period. It will be observed therefore that

the dose of each challenging organism employed was a critical one, since it was based on mortality rather than on morbidity. Cultures of the heart blood were made on most moribund and dying mice, with positive results in the majority.

RESULTS

On the completion of the mouse serum protection tests, an analysis of the results showed that there were no significant differences in relation to the different formulas of the vaccines or the different dosage schedules employed. In the circumstances and since the purpose of the investigation was to obtain information on the fundamental question of whether or not the polyvalent stock vaccines were absorbed after oral administration, with the production of protective antibodies, the data were grouped for analytic purposes. As previously stated, the serums of those adults

TABLE 1—*Results of Mouse Protection Tests for Natural and Acquired Antibodies in the Serums of Adults After the Oral Administration of Stock Polyvalent Bacterial Vaccines and Placebo*

Challenging Organisms	Following Administration of Vaccines*	Following Administration of Placebo*	Culture Controls*
Str. hemolyticus (group A)	121/556 21.8%	12/174 6.9%	1/78 1.3%
Pneumococcus (type I)	98/556 17.6%	9/174 5.2%	0/84 0%
K. pneumoniae (type A)	187/556 33.6%	38/174 21.3%	0/84 0%

* Number of surviving mice over total number inoculated, with percentages of survivals.

collected before the administration of the vaccines and placebo were only tested if the serums taken after administration of the tablets showed the presence of antibodies.

An analysis of the results observed on all 151 serums collected after administration of the vaccines and placebo is summarized in table 1, which shows the percentages of mice surviving, because of the presence of both natural and acquired protective antibodies in the serums for hemolytic streptococci, type I pneumococci and K pneumoniae. This accounts for the fact that some of the serums of subjects who took placebo tablets showed protective antibodies, which were obviously of the natural type, since there was no evidence whatsoever of protective antibodies produced by the oral administration of the placebo.

The results shown in table 2 are also of clinical interest. In this table all serums containing natural protective antibodies were excluded from consideration. In the circumstances it will be observed that none of the serums of 35 subjects taking placebo tablets showed any evidence of protective activity against the three challenging organ-

isms employed, whereas 19.8 per cent showed the presence of protective antibodies against hemolytic streptococci, 25 per cent against type I pneumococci and 19.8 per cent against K pneumoniae as the result of immunization with the vaccines.

In this connection, however, it was frequently observed that serums collected after the administration of vaccines protected more of the mice employed than serums collected before administration. This suggested

TABLE 2—*Human Adults Acquiring Protective Antibodies Through the Oral Administration of Stock Polyvalent Bacterial Vaccines and Placebo*

Challenging Organisms	Following Administration of Vaccines*	Following Administration of Placebo*
Str. hemolyticus (group A)	23/116 19.8%	0/35 0%
D pneumoniae (type I)	29/116 25%	0/35 0%
K pneumoniae (type A)	23/116 19.8%	0/35 0%

* Number of adults acquiring immunity over total number of adults, with percentages acquiring immunity.

TABLE 3—*Human Adults Acquiring or Adding to Natural Protective Antibodies Through the Oral Administration of Stock Polyvalent Bacterial Vaccines and Placebo*

Challenging Organisms	Following Administration of Vaccines*	Following Administration of Placebo*
Str. hemolyticus (group A)	36/116 31%	1/35 2.8%
Pneumococcus (type I)	39/116 33.6%	0/35 0%
K pneumoniae (group A)	42/116 36.2%	3/35 8.6%

* Number of serums showing the presence of antibodies over total number of serums tested, with percentages showing the presence of antibodies.

the presence of acquired protective antibodies in addition to the presence of natural antibodies. Obviously, it is difficult to evaluate such results in terms of acquired antibodies in view of the chances of experimental errors. This seems to be especially true because of the fact that it will be observed in table 3 that the administration of the placebo apparently was followed by an increase of antibodies against hemolytic streptococci in 1 of 35 serums and an increase of antibodies against K pneumoniae in 3 of thirty-five serums, increases which we attribute to experimental error or too close an analysis of the results of the protection tests with individual serums. With these considerations in mind, however, it will be

observed that approximately 31 per cent of the serums of 116 adults showed acquired protective antibodies in addition to natural antibodies against hemolytic streptococci, 33.6 per cent against type I pneumococci and 36.2 per cent against K pneumoniae after the administration of the vaccines

COMMENT

In general terms, the results of this investigation have shown, therefore, that stock polyvalent bacterial vaccines by oral administration may engender the production of demonstrable amounts of protective antibodies in at least some adults, as has been observed in some mice. This affords support for the claims of numerous investigators that the oral administration of such vaccines may be of value in protecting human beings against the secondary bacterial infections of the common cold or shortening their duration and ameliorating their severity.

We have not been interested primarily in this phase of the problem but have merely sought to determine by mouse serum protection tests whether or not there was a basis for the oral administration of stock polyvalent vaccines to human beings for active immunization against these secondary bacterial infections. For this reason we have not attempted to review the large literature on the subject because of the difficulties in drawing reliable conclusions and particularly since factors other than the ingestion of bacterial vaccines may account wholly or partly for escape from common colds. All the results were analyzed statistically by the chi square method. These analyses showed that a significant number of human subjects acquired protective antibodies against hemolytic streptococci, pneumococci of type I and K pneumoniae after the oral administration of the stock polyvalent bacterial vaccines employed. Whether or not protective antibodies are produced against other pneumococci, streptococci of the viridans group, gamma streptococci, staphylococci, H influenzae and Neisseria cannot be stated.

SUMMARY

Enteric-coated tablets of stock polyvalent vaccines prepared of the desiccated bacteria and their soluble products commonly involved in the production of the secondary bacterial infections of the common cold were administered orally to 116 adults, placebo tablets were administered to 35 adults as controls.

After administration of the tablets mouse protection tests were conducted with the serums of both groups for antibodies against hemolytic streptococci, type I pneumococci and K pneumoniae.

The oral administration of the placebo tablets did not produce protective antibodies against any of the three challenging organisms in 35 adults.

The oral administration of tablets of the bacterial vaccines produced protective antibodies against hemolytic streptococci in 19.8 per cent against type I pneumococci in 25 per cent and against K pneumonae in 19.8 per cent of 116 adults when the serums were tested against 2 minimum lethal doses of the respective organisms.

The serums of some adults were found to contain natural protective antibodies against the three challenging organisms. These natural antibodies plus those produced by the vaccines accounted for the combined antibodies against hemolytic streptococci in approximately 31 per cent, against type I pneumococci in approximately 33.6 per cent and against K pneumonae in approximately 36.2 per cent of 116 adults.

Under the conditions of these experiments, it appears that the oral administration of tablets prepared of desiccated organisms and their soluble products may produce protective antibodies against hemolytic streptococci, type I pneumococci and K pneumonae in a statistically significant number of adults.

SULFAMYLON® AND STREPTOMYCIN IN TREATMENT OF INFECTIONS OF THE EAR

A Preliminary Report

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AND

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THE USE of sulfamylon® and streptomycin in local treatment of otitis media with or without acute exacerbation seems to be a valuable addition to the armamentarium of the otolaryngologist. As will be shown, the use of this combination has dramatic results in clearing some types of infections, but in others especially external otitis it has no effect.

Sulfamylon®, a sulfanilimide derivative, has a chemical formula of $\text{SO}_2\text{NH}_2 \cdot \text{C}_6\text{H}_4 \cdot \text{CH}_2\text{NH}_2 \cdot \text{HCL}$, and a chemical name is 4-(aminomethyl)-benzene sulfonamide hydrochloride. It has a molecular weight of 222.67 and a melting point of 260 to 265 C (corrected). It is a white crystalline material, soluble in water to 50 Gm per hundred cubic centimeters at 25 C and is weakly acid in reaction. Experimentally, this drug is excreted rapidly from the kidneys in three to four hours in the form of a heavy precipitate of a colorless crystalline material. This substance is a deaminated and oxidized product, the chemical name of which is para-carboxybenzene sulfonamide.

Brewer¹ found that in vitro sulfamylon® is highly effective against the anaerobic bacteria *Clostridium welchii*, *Clostridium chauvoei*, *Clostridium septicum*, *Clostridium botulinum*, *Clostridium histolyticum*, *Clostridium tetani* and *Clostridium novyi*, grown in his thioglycollate sodium medium. Sulfamylon®, on comparison, was found to be bactericidal against these organisms, while sulfathiazole sodium and sulfadiazine sodium not only were found to be nonbactericidal, but were observed to permit some growth of the bacteria in their presence. Quantitatively, sulfamylon® was bactericidal or bacteriostatic to *Cl welchii*, *Cl tetani*, *Cl histolyticum* and *Clostridium oedematiens* in dilutions up to 1:25,000, while sulfathiazole sodium did not prevent growth of the same bacteria in a 1:100 dilution.

¹ Brewer, J. H. Clear Liquid Mediums for "Aerobic" Cultivation of Anaerobes, J. A. M. A. 115:598 (Aug. 24) 1940.

Lawrence² showed the results of activity against the various anaerobic bacteria in both veal-dextrose serum and Brewer's thioglycollate medium, as contrasted with both sulfathiazole sodium and sulfadiazine sodium (table 1)

Hamre³ and his associates showed that 2 to 10 Gm per kilogram of body weight, given perorally to mice, did not produce any evidence of toxic effects. When a 40 per cent solution of sulfamylon® was injected subcutaneously in mice weighing approximately 18 to 20 Gm, no deaths resulted with a dose of less than 6 Gm per kilogram. The intravenous administration of the solution into mice weighing 20 Gm at the rate of 0.1 cc per fifteen seconds showed a LD₅₀ of 920 Gm per kilogram. Experiments with rats showed an oral LD₅₀ of 7.4 Gm per

TABLE 1³—Highest Dilutions of Sulfamylon®, Sodium Sulfathiazole and Sodium Sulfadiazine Showing Antibacterial Effects Against Various Gram-Positive Cocci*

Organisms	"Sulfamylon"		Sulfathiazole Sodium		Sulfadiazine Sodium	
	Bacteriostatic	Bactericidal	Bacteriostatic	Bactericidal	Bacteriostatic	Bactericidal
<i>Streptococcus haemolyticus</i>	1 32,000	1 8,000	1 8,000	1 4,000	1 2,000	<1 1,000
<i>Pneumococcus</i> type I	1 32,000	1 4,000	1 32,000	1 4,000	1 8,000	1 1,000
<i>Pneumococcus</i> type II	1 32,000	1 16,000	1 32,000	1 8,000	1 4,000	<1 1,000
<i>Pneumococcus</i> type III	1 32,000	1 8,000	1 32,000	1 4,000	1 16,000	<1 1,000
<i>Str. viridans</i> 74	1 16,000	1 400	<1 100	<1 100	<1 100	<1 100
<i>Str. viridans</i> 1,404	1 8,000	1 4,000	<1 100	<1 100	<1 100	<1 100
<i>Str. faecalis</i> 7,080	1 400	<1 100	<1 100	<1 100	<1 100	<1 100
<i>Str. faecalis</i> 4,080	1 400	<1 100	<1 100	<1 100	<1 100	<1 100

* Figures preceded by < indicate that the highest drug concentration tested proved ineffective

kilogram. Toxicity experiments were also conducted with rabbits and dogs, and these also showed a high lethal threshold. The effects of the solution on the circulation and respiration of dogs were also studied experimentally. No change except for a slight decrease in blood pressure occurred with subcutaneous injection. Intraperitoneal injection did produce a pronounced drop in blood pressure. The conjunctival mucosa and the mucosa of the urinary bladder were also studied by Hamre³ for signs of local irritation. Solutions up to 2 per cent were found to have no effect on the conjunctiva, and solutions up to 20 per cent had no effect on the mucosa of the urinary bladder.

Streptomycin is produced by certain strains of the actinomycete *Streptomyces griseus*. The possible structure of streptomycin has not been definitely proved, but, under acid hydrolysis, streptomycin yields

² Lawrence, C. A. J. Bact. **49**: 149, 1945

³ Hamre, D. M., and others. Proc. Soc. Exper. Biol. & Med. **55**: 170, 1944

two moieties streptidine and a disaccharide-like compound, streptobiosamine. The complete range of antibacterial activity of this drug has not yet been determined,⁴ but clinically it has been used with best results in the treatment of infections due to susceptible gram-negative organisms. The dose recommended for topical application is 250 to 500 micrograms per cubic centimeter. If the infecting organisms seem unusually resistant, higher concentrations may be used, as they are easily tolerated by the tissues. The toxicity of streptomycin is very low, and no toxic reactions to its local application have been reported.

In our search for a local therapeutic agent for aural infections, several factors were considered. As necessary attributes, we desired (1) the greatest antibacterial action with the least toxicity to the patient (2) the widest range of antibacterial action, (3) the easiest and most efficacious physical application of the medicament to the affected part and (4) the greatest chemical stability of the agent to be used.

As determined by Howes,⁵ sulfamylon[®] seemed to be superior to other antibacterial substances tested, while streptomycin was second best. Neither had any toxicity when applied locally, thus fulfilling our first requirement. Sulfamylon,[®] as previously shown, seemed to have a predilection for bactericidal and bacteriostatic action against gram-positive organisms, while streptomycin tended to exert bactericidal and bacteriostatic action against gram-negative organisms. Thus, the substances fulfilled our second requirement by giving us the greatest antibacterial range possible. In fulfillment of our third requirement, both sulfamylon[®] and streptomycin were easily soluble, while effective at low concentrations and in solution, and, in fulfillment of our fourth both were stable indefinitely at room temperature. For these reasons, it was decided to use the combination of sulfamylon,[®] 5 per cent, and streptomycin, 0.02 per cent,⁶ because these substances possessed the best qualities for local action in the treatment of aural infections.

Clinically, Beyer⁷ used sulfamylon[®] and sulfanilamide (1:9) locally on 200 patients as a prophylactic against infection and in treatment of infected wounds and concluded that it was a valuable aid in their treatment. Clark⁸ used a 1 per cent sulfamylon[®] solution as a prophylactic, especially against *Bacillus pyocyaneus* (*Pseudomonas aeruginosa*) before operation in his ophthalmic cases. After its use there

4 Clinical use of Streptomycin, Meick and Company, Inc. 1947

5 Howes, E. L. Surg., Gynec. & Obst. **83** 1, 1946

6 This combination was supplied by Winthrop-Stearns Inc., for clinical research.

7 Beyer, W. Zentralbl. f. Chir. **68** 1730 1941 abstracted War Med. **4** 121, 1943

8 Clark, W. B. Local Use of "Sulfamylon" (Para-[Aminomethyl]-Benzene Sulfonamide Hydrochloride), Arch. Ophth. **38** 682 (Nov.) 1947

were no cases of infection with this organism. There were also no reactions to the drug in his series of 84 cases. Howes⁹ conducted studies on the local chemotherapy of wounds, testing streptomycin, sulfamylon®, calcium penicillin, parachlorophenol, tyrothricin and benzalkonium chloride (zephiran chloride®). For local chemotherapy he found that sulfamylon®, 5 per cent, seemed superior to the other antibacterial substances tested, possessed the widest range of antibacterial activity and was relatively nontoxic. It was also found that a mixture of sulfamylon®, 5 per cent, and streptomycin was nontoxic, was relatively stable in the wound and had almost a complete range of antibacterial activity, including the anaerobes of gas bacillus infection. "However, it was unsuccessful in the treatment of open wounds containing slough and sequestrum⁹." This statement is of importance in dealing with the application of this drug in otolaryngology. Howes,⁹ in his experiments with contaminated wounds of rabbits, found that a 5 per cent solution of sulfamylon® combined with a solution of streptomycin (200 units per cubic centimeter) had a high antibacterial action and low toxicity. However, he also found that when the infection had had time to invade the tissues this solution failed to clear it up, or even to speed resolution. In his conclusions, he stated that this failure may have been due to the fact that the solution was prevented from reaching the bacteria, either by the physical barrier of exudate or by the inclusion of the organisms within the dead leukocytes. These bacteria remained susceptible *in vitro*, however. In his later work,¹⁰ Howes found that prevention of infection could be obtained experimentally as late as forty-eight hours by débridement of crushed tissues and by washing the wound with the sulfamylon® and streptomycin solution. In order to hasten resolution, however, the slough must be liquefied and removed and the bacteria within the leukocytes killed. In December 1947, Fox¹¹ investigated the use of sulfamylon® in rhinosinusitis. He used it as a nasal spray and as nose drops and in instillations into infected maxillary sinuses. However he found it necessary to use a vasoconstrictor in conjunction with the drug. He used a 1 per cent solution of sulfamylon® against a variety of bacteria and drew the following conclusions: 1 In local treatment of sinusitis sulfamylon® was more effective than penicillin. 2 There is no local or constitutional reaction to the drug. 3 Sulfamylon® is the most valuable of the available chemotherapeutic agents in the local treatment of acute rhinitis and sinusitis. 4 The drug exerted its poorest effect against *P. aeruginosa*. Our investigation supports the last conclusion.

⁹ Howes, E. L. *Ann. Surg.* **124**: 268, 1946.

¹⁰ Howes, E. L. *Am. J. Med.* **2**: 449, 1947.

¹¹ Fox, S. L. *Ann. Otol., Rhin. & Laryng.* **56**: 946, 1947.

CLINICAL INVESTIGATION

Method and Material—In the investigation of sulfamylon® and streptomycin therapy, 29 patients were treated. All had aural infections varying from acute external otitis to a chronic otitis media with cholesteatoma. All types of infections were present, and cultures were made wherever possible. The ages ranged from 6 years (acute otitis media) to 67 (chronic otitis media). Because of an insufficient amount of material and in order to control the frequency of administration, the drug was not dispensed to the patient.

The general procedure of treatment of these patients was as follows. After the diagnosis, a culture was obtained when possible. The ear was cleansed thoroughly by dry wiping. We consider this part of the procedure to be very important for the following reasons. Any moisture, either serous or purulent, would prevent the full action of the drug on the infected membranes, both by dilution of the drug and by acting as an actual physical obstruction (Howes⁹). After the removal of the debris, wax, pus or discharge of any nature, the patient was instructed to lie on a couch in the office with the affected ear up. The sulfamylon® was then dropped into the ear and allowed to permeate the structure for fifteen to thirty minutes. A varying amount of the solution was used, depending on the caliber of the external auditory canal and the size of the mastoid cavity. The amount instilled into the ear ranged from 0.25 to 0.50 cc.

In some of our later cases a special needle with a blunt end was devised, so that the solution could be directly instilled into the middle ear through a perforation of any size. This was found to be a valuable adjunct in the treatment. It was reasoned that an extremely small perforation, by reason of pus or granulations in the middle ear, could prevent any of the solution from seeping through the opening. In many ears with chronic otitis media granulations occlude the perforation, these granulations tend to occlude the opening in the drum membrane and prevent contact of the drug with the pathologic middle ear. The granulations were occasionally cauterized with a bead of silver nitrate to check any hemorrhage resulting from the cleansing. After the instillation, the patient was allowed to leave and was requested to have the procedure repeated every other day. Because of transportation and other difficulties, the intervening time, in a number of instances, was of necessity lengthened considerably. The procedure was repeated every other day when possible until a definite reduction in amount of drainage was noted. Then the time interval was lengthened to once a week, once every two weeks or once a month, until complete cessation of drainage was accomplished. The longest period of treatment recorded was five months and the shortest four days, the average length of treatment being about eight weeks. Several patients did not return for treatment, but the results of the last observation has been recorded.

Results—Prior to the use of sulfamylon® and streptomycin, many of these patients had been under the care of competent otologists, who had used various treatments without results. Sixteen patients with chronic otitis media showed some reduction in the amount of drainage, and in 11 of this number, a dry ear resulted, while the others had a noticeable lessening of the volume of flow. It is interesting to note that in cases in which all, or a large portion, of the drum membrane was absent better and quicker results were obtained. This was, of course, a direct result of the amount of diffusion of the drug over the affected part. In those cases in which only a small perforation was

present, the technical procedure of application of the drug to the middle ear was difficult. Twelve patients had granulations in the middle ear or the external auditory canal, in 7 of these treatment resulted in complete removal and in 4 in a definite reduction in amount, 1 patient did not return for treatment. One patient in this group had a pseudo-cholesteatoma which had disappeared at the end of treatment. Of 6 patients treated for acute otitis media, 5 had a striking reduction of the disease, while 1 did not return for treatment. All the patients with acute disease were given sulfadiazine or penicillin in conjunction with local therapy. For this reason, no exact evaluation of the efficacy of the treatment could be made, although the ears with the acute infection so treated seemed to dry and clear more rapidly than others with a similar condition in which the local medication was not used. Two of these patients had a perforated drum membrane on their first visit. One patient had a large granulation, which subsided quickly. Six patients had either a simple or a radical mastoidectomy one or more times, the wound continuing to drain after operation until the local sulfamylon® therapy was instituted. Six patients were treated for external otitis, both acute and chronic, and no improvement was noted. In fact, in 3 patients the symptoms and the drainage were aggravated. Several patients had acute external otitis superimposed on chronic otitis media. Before any therapy could reach the middle ear, the acute infection of the external canal had first to be controlled. One patient with acute catarrhal otitis media was treated with no improvement.

Cultures were obtained in a total of 14 cases. In 6 of these cases the cultures yielded entirely, or in part, *P. aeruginosa*, in 6, *Staphylococcus albus*, in 3, *Staphylococcus aureus*, in 1, an undifferentiated streptococcus, in 1, an anaerobic streptococcus, in 1, a streptococcus of the viridans group, and in 1, *Aspergillus nigr*. In 2 cases of infection with *P. aeruginosa* a dry ear was obtained. In both cases there were large radical mastoidectomy cavities, through which the medicament could permeate freely, but even then constant treatment for four months was required. In all our other cases of infection with this organism the ear continued to drain, although the amount was slightly decreased. In 1 case of infection with a member of the *Staph. albus* group combined with *P. aeruginosa* the ear continued to drain, while in a second case of infection with *Staph. albus* combined with *Staph. aureus* the patient did not return for treatment. In 2 of the cases of infection with *Staph. aureus* a dry ear resulted. Except for the cases of infection with *P. aeruginosa* and of infection with this organism combined with *Staph. aureus*, treatment terminated in a dry ear in all cases of otitis media. In 3 cases of external otitis—infection with anaerobic streptococcus, *P. aeruginosa* and *A. nigr*, respectively—there was no improvement.

TABLE 2—Results of Treatment of Aural Infections with Sulfamylon® and Streptomycin

Patient	Age, Yr	Diagnosis	Duration of Drainage	Complications	Condition of Drum Membrane	Culture	Final Results
1	45	Chronic Otitis Media, left	20 yr	Large granulations and cholesteatoma	Large perforation	80% Staph albus 20% hemolytic Staph aureus	Subsidence of drainage, dissolution of granulations and cholesteatoma
2	42	Chronic Otitis Media, right	4 mo	Moderate granulations	Large perforation	No culture	Complete subsidence of drainage dissolution of granulations
3	55	Chronic Otitis Media, right	20 yr	None	Very small perforation	P aeruginosa	Very slight decrease in amount of drainage, improvement of physical well being
4	66	Chronic Otitis Media, right	24 yr	Large granulations	Large perforation	P aeruginosa	Slight decrease in amount of drainage
5	33	Chronic Otitis Media, right	19 yr	Simple mastoidectomy	Very small perforation	Staph albus, P aeruginosa	Slight decrease in amount of drainage
6	29	Chronic Otitis Media, right	25 yr	Large granulations filling radical mastoidectomy cavity	Radical mastoidectomy cavity	P aeruginosa	Complete subsidence of drainage dissolution of granulations
7	35	Recurrent Chronic Otitis Media, right	4 days	Large granulations	Large perforation	No culture	Complete subsidence of drainage dissolution of granulations
8	56	Chronic Otitis Media, right	3 yr	None	Medium perforation	No culture	Complete subsidence of drainage healing and closure of right drum membrane
9	20	Chronic Otitis Media, right	10 yr	None	Medium perforation	Staph albus	Complete subsidence of drainage
10	21	Chronic Otitis Media, left	2 mo	Skull fracture through middle ear, with secondary otitis media granulation	Medium perforation	No culture	Complete subsidence of drainage dissolution of granulations
11	25	Chronic recurrent Otitis, right	1 yr	Simple mastoidectomy, large granulations	Large perforation	Hemolytic Staph aureus	Complete subsidence of drainage dissolution of granulations
12	23	Chronic Otitis Media, right	17 yr	Radical mastoidectomy cavity, filled with granulations	Radical mastoidectomy cavity	P aeruginosa	Complete subsidence of drainage dissolution of granulations
13	31	Chronic Otitis Media, right	3 yr	Simple mastoidectomy, small granulations	Small perforation in Shrapnell's area	Staph albus, Str viridans	Complete subsidence of drainage
14	26	Recurrent Otitis Media, left	4 days	None	Medium perforation	No culture	Complete subsidence of drainage
15	31	Chronic Otitis Media, right	15 yr	None	Medium perforation	No culture	Complete subsidence of drainage subjective improvement in hearing
16	22	Chronic Otitis Media, left	14 yr	Two simple mastoidectomies	Medium perforation	No culture	Complete subsidence of drainage closure of perforation in drum membrane
17	30	Acute Otitis Media, right	1 wk	None	Intact	No culture	Subsidence of drainage return of drum membrane to normal
18	6	Acute Otitis Media, right	3 days	None	Large granulation	None	Return of drum to normal, disappearance of granulations
19	39	Acute Otitis Media, right	2 wk	None	Intact	None	Complete subsidence of drainage
20	33	Acute Otitis Media, left	4 days	None	Intact	None	Complete subsidence of drainage
21	67	Acute Otitis Media, right	2 wk	None	Large perforation	None	Complete subsidence of drainage closure of perforation
22	20	Acute Otitis Media, right	2 wk	Medium granulations	Medium perforation	Staph aureus and Staph albus	Reduction in amount of drainage, patient did not return for further treatment
23	35	Acute External Otitis, right	1 wk	None	Perforation, right	No culture	No improvement
24	32	Acute Exacerbation of Chronic External Otitis, Bilateral	10 yr	None	Intact	Anaerobic streptococcus	No improvement
25	48	Acute External Otitis	1 wk	None	Intact	P aeruginosa	No improvement
26	41	Acute External Otitis	2 mo	None	Small perforation	Staph albus	No improvement
27	35	Acute External Otitis, right	2 mo	Small perforation	Small perforation	A Niger	No improvement
28	52	Acute External Otitis, right	3 days	Granulations in external canal	Intact	Staph albus	No improvement
29	48	Acute Catarrhal Otitis Media, right	None	None	Intact	No culture	No improvement

In order to obtain the best results with sulfamylon® and streptomycin therapy, the following procedures and condition should be fulfilled (1) thorough cleansing and drying of the area to be treated, (2) application of the solution every day or every other day until drainage has ceased, or at least has been materially reduced, (3) a large perforation of the drum membrane or an open ear cavity, (4) free drainage and liquefaction of secretions, (5) culture

Data on the entire series of cases with the final results in each case, are presented in table 2

CONCLUSIONS

A solution of sulfamylon®, 5 per cent, and streptomycin, 0.02 per cent, is an effective local bactericidal agent in the treatment of chronic otitis media

No local or systemic reaction to the drugs was noted in this series of cases

This medication is not effective in the presence of an intact ear drum membrane

There is no effective antibacterial action on external otitis, either acute or chronic

There is very little bactericidal action on *P. aeruginosa*

The solution of sulfamylon®, 5 per cent, and streptomycin, 0.02 per cent, cannot exert its full bactericidal effect in the presence of pus or debris and is more effective where there is free drainage of the liquefied exudate

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PREVENTION OF MOTION SICKNESS BY INTRAVENOUS INJECTION OF SODIUM BICARBONATE

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THE TERM "motion sickness" is here meant to include the conditions produced by accelerated motion of trains, ships, planes or other vehicles. Rosenbach called this condition "*Kinetosen*," and Starkenstein termed it "*Bewegungskrankheit*," which means sickness caused by undulation. This motion sickness, or "acceleration disease," is produced by rectilinear acceleration acting on the otoliths in the labyrinth.

The experiments made by my associates and myself on animals and man indicate that intravenous injection of sodium bicarbonate dissolves the otoliths and prevents the symptoms usually produced by motion sickness.

These experiments were conducted by exposing rabbits to the up and down motion produced by an apparatus making sixty-three "up and down" trips per minute for a distance of 43 cm. During this process, various changes in the rabbit were recorded. There was a decided increase in respiration and a noticeable inspiratory quickening. Gastric and intestinal action were quickly suppressed and soon ceased. When the rabbit had been exposed to the action fifteen minutes, the following changes in the blood were detected: decrease in lymphocytes, decrease in alkali reserve, increase in sugar, lowered calcium level, increase in sedimentation rate and lowered coagulation time. A fall in rectal temperature was also noted, along with urinary changes showing increased specific gravity, glycosuria, increased creatine and creatinine. In those animals exposed to the movement three hours a day for a total of more than a hundred hours, considerable degeneration appeared in the ganglion cells of the sympathetic nerves at the neck and abdominal cavity but not in the ganglion nodosum of the vagus nerve.

According to the literature, these phenomena are produced by strain on the sympathetic nervous system. To corroborate this, we exposed animals in which the vagus nerve was cut to the same motion. These animals reacted as the animals previously described did. However, when animals that had undergone sympathectomy were exposed to this

up and down motion, the described phenomena were almost completely absent (the sympathetic nerves had been cut at the neck and at the intestine) In the animals that had had a vagotomy there was a decrease in lymphocytes, but when the solar plexus was removed this did not occur This situation indicates that the changes caused by exposure to the up and down motion are produced by excitement of the sympathetic nerves

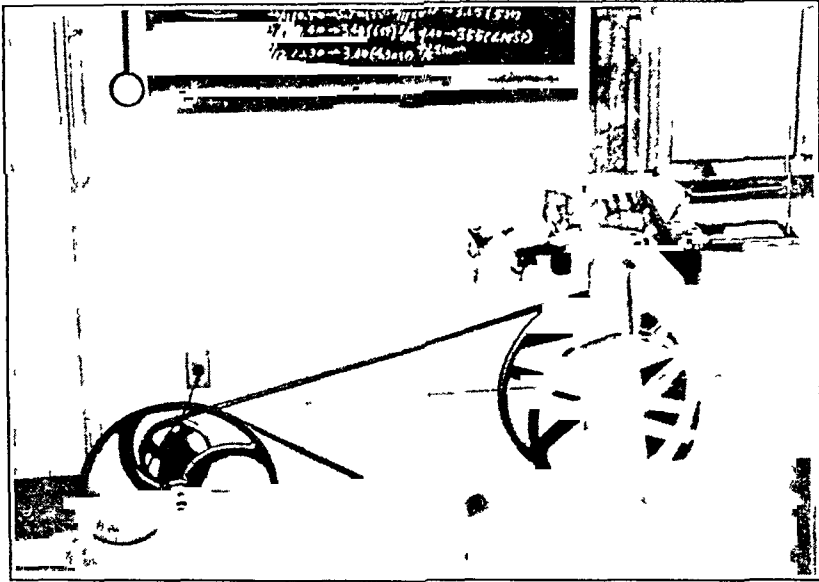


Fig 1—Rising and falling apparatus used with rabbit

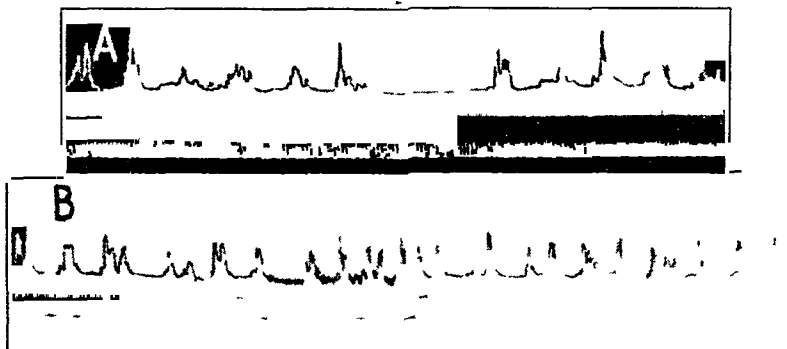


Fig 2—Chart of movement of intestine at time of elevation *A*, animal with vagus nerve cut Movement of intestine stops while animal is rising and falling *B*, animal with splanchnic nerve cut Movement of intestine does not stop while animal is rising and falling

The experiment was next repeated on animals in which the labyrinths were destroyed Similar to the sympathectomized animals, these rabbits also revealed no changes in the blood, urine, respiration or intestinal tract This indicates that the action of the sympathetic nerves induced during this experiment is controlled by the labyrinth

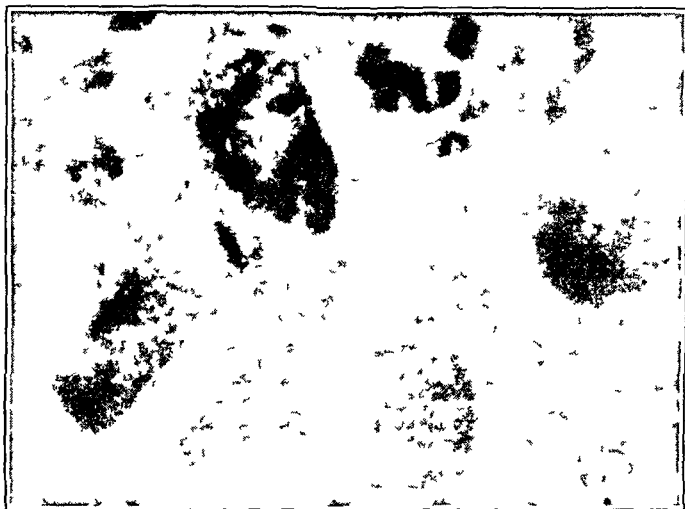


Fig 3—Degeneration of cervical ganglion cells

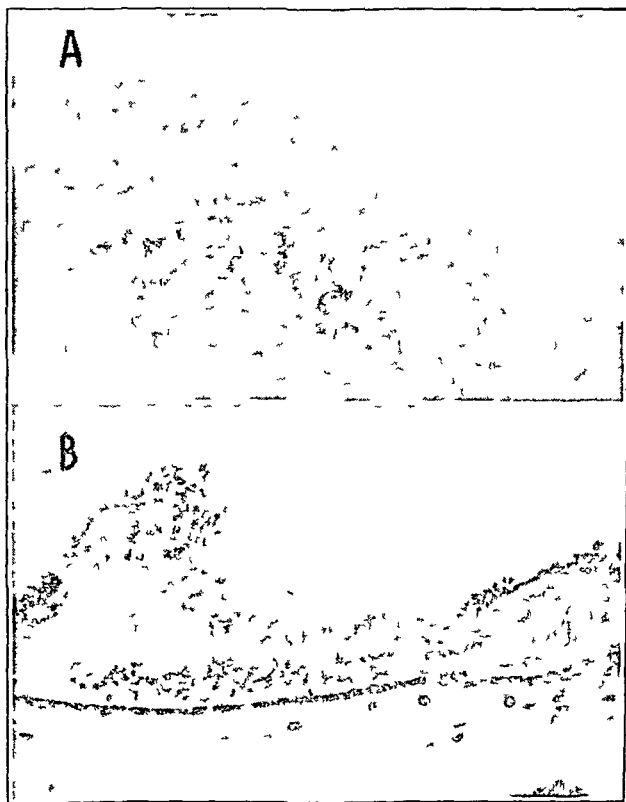


Fig 4—Removal of otolithic membrane by subjection of rabbit to the force of centrifugal motion *A*, macula, *B*, otolithic membrane

While working in Professor Wittmaack's laboratory in Hamburg, I observed that guinea pigs subjected to centrifugal motion had their otoliths torn off and could not be affected by rectilinear motion. To confirm this result, I centrifuged a number of rabbits in a hare centrifuge and used a force of about 360 g. As was expected, the symptoms and signs of motion sickness did not appear, and histologic sections later

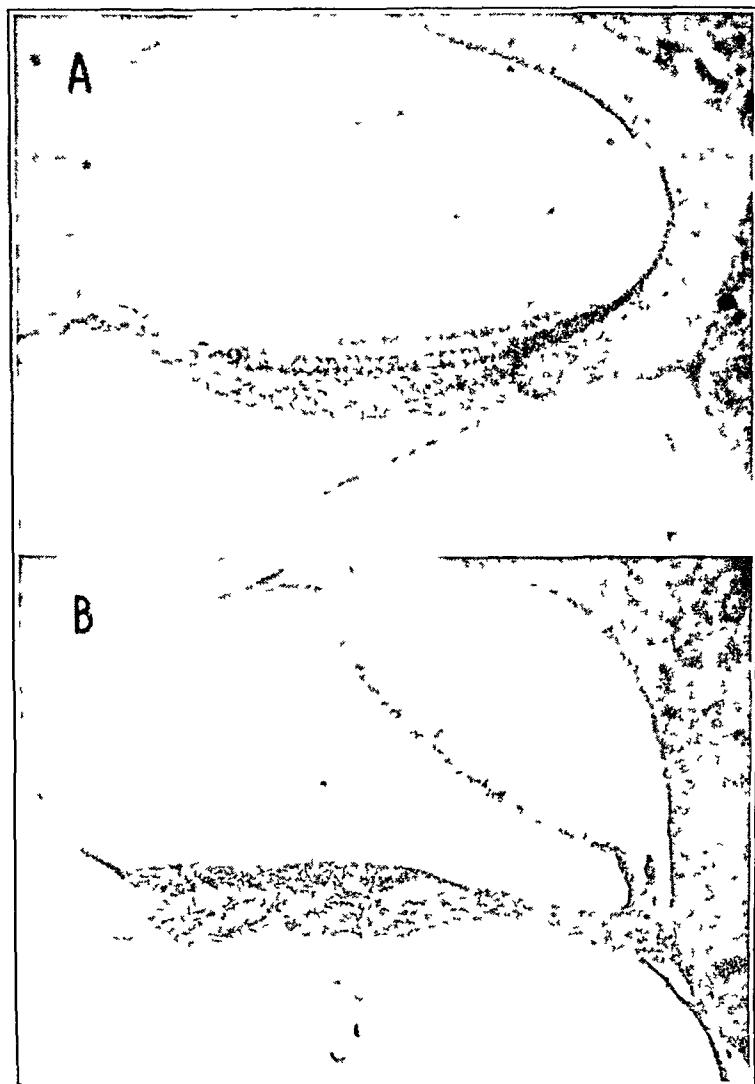


Fig 5—*A*, normal rabbit utricle, *B*, utricle after injection of sodium bicarbonate. Low magnification

showed that the otoliths in these animals had disappeared. As a result of these experiments, I concluded that removal of the otoliths in animals, and perhaps in man, would possibly prevent the condition of motion sickness.

A most interesting observation is that there seems to be no abnormal change in animals deprived of their otoliths, no change could be detected

in their equilibrium, movements or daily routine. According to the hypotheses of Mach, Breuer, and Crum Brown, otoliths are essential to the perception of change in position, and without them, body equilibrium would be difficult to maintain. But no such phenomenon occurred in the experiments. This led me to believe that the removal of otoliths in man would not hinder him in any way and would prevent motion sickness. Since centrifuging a human being was out of the question,



Fig 6—High magnification of portions of fields in figure 5

an approach directed toward chemically dissolving the otoliths in a person was decided on. Observing that the otolithic crystals were formed even better in animals that had received diluted hydrochloric acid intravenously (1 cc of 0.5 per cent solution once daily), I decided to use sodium bicarbonate. Five cubic centimeters of 5 per cent solution of sodium bicarbonate was injected into the veins of the ears of a number of rabbits. All these animals responded to the up and down motion as if they had been sympathectomized and showed none of the signs of

motion sickness Histologic examination revealed that the otolithic crystals were gone, with a fine mesh and the glue substance between the former crystals remaining All these animals responded as if their labyrinths had been destroyed

Following is an account of the chemical investigation of this phenomenon

I made an experimental test to see what chemical caused the disappearance of the otolithic crystals I made an injection of such sub-

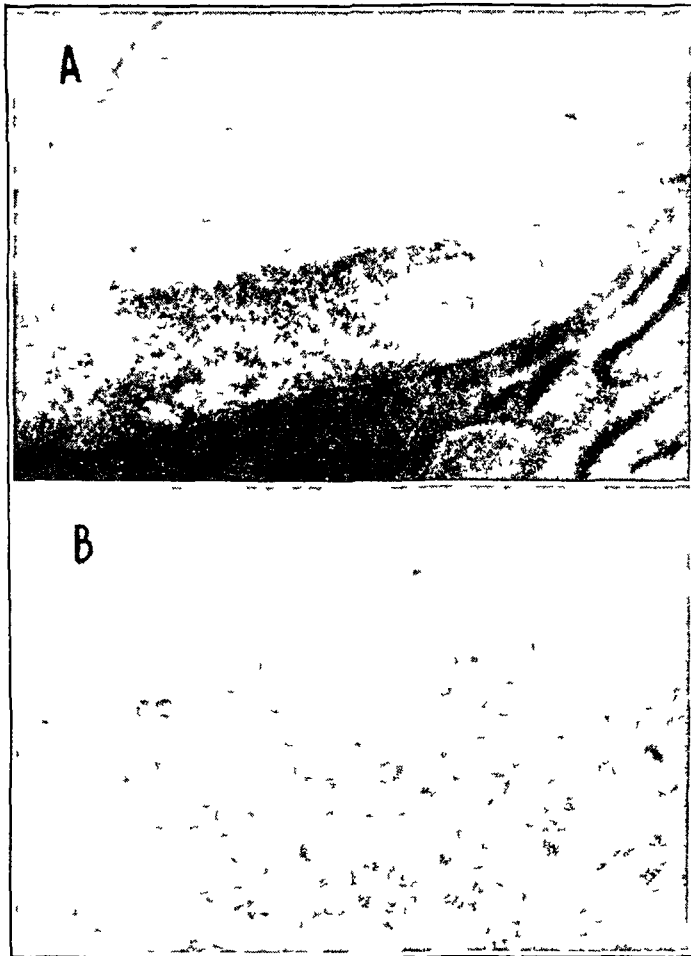


Fig 7—Removal of otolithic crystal by intravenous injection of sodium bicarbonate in the case of nasal sarcoma *A*, low magnification, *B*, higher magnification

stances as sodium bicarbonate and sodium oxalic acid, but the results showed that the otoliths did not disappear What makes the otoliths dissolve? It appears that the carbon dioxide generated from sodium bicarbonate works on the solid otolithic crystals of calcium carbonate and produces soluble calcium bicarbonate, the same as in the case of marble becoming dissolved by efflorescence

To generate carbon dioxide from sodium bicarbonate requires a temperature of 150 C or higher. This fact coincides with that induced from the animal experimentations. When sodium bicarbonate is sent into the blood of frogs, cold-blooded animals, through their heart, their otolithic crystals do not dissolve. It is also a fact that when carbon dioxide works on the otolithic crystals they do dissolve.

I scratched the otolithic membrane with a sharp spoon by inserting the spoon into the labyrinth of a frog and injected the substance thus taken into water in test tubes. The transparent water became milky. Microscopic examination of a drop of this water revealed innumerable various-sized crystals of the otolith floating on it. I then inserted a pipet into the test tube and blew through it to allow carbon dioxide to work on the liquid. The milky liquid became transparent by degrees. When this practice was continued for thirty minutes or so, the liquid became perfectly transparent, and in microscopic examinations it was difficult to notice any otolithic crystals.

It is inconceivable that sodium bicarbonate injected into a vein will generate carbon dioxide at once and will reach the labyrinth and dissolve the otolithic crystals. It seems more likely that the sodium bicarbonate solution reaches the labyrinth and gets to the cavity below the otolithic membrane, then the work of the carbon dioxide is performed.

APPLICATION OF OBSERVATIONS TO MAN

The commonest symptoms of seasickness are fatigue, depression, dizziness, weakness, facial pallor, difficult breathing, nausea and vomiting. Excluding the psychologic symptoms, it is evident that the physical ones, such as facial pallor, dyspnea and, especially, vomiting, are results of action of the sympathetic nervous system. According to previous studies, vomiting is produced by strong contraction of the abdominal wall, opening of the cardia and closing of the pyloric sphincter. The contraction of the abdominal wall in the rabbits was produced by stimulation of the sympathetic nerves. These observations indicate that seasickness in general is produced by strain on the sympathetic nervous system. Great care was taken with the use of sodium bicarbonate in man to obviate any deleterious effects.

A man aged 20 volunteered for this study. He was born of a fisherman's family, but because of constant seasickness was not able to perform the only job available to him. Even riding in trains or steamers made him nauseated. Physical examination indicated that his condition was essentially normal. When he was placed in a rotating chair, or if he rode in an elevator, he experienced profound nausea, vomiting and dizziness. He was given an intravenous injection of 40 cc of 5 per cent solution of sodium bicarbonate, and the tests with the rotating chair and elevator were repeated. This time he had no reaction and was not even disturbed by a boat ride on very rough water.

From a battalion of 474 men in the Japanese Army, 40 were selected who complained of chronic seasickness, as well as 6 who professed to being seaworthy. All these men received the Aschner test, in which both eyes were pressed to the extent that pain was felt, and then the pulse rates were measured. Those with a decrease in pulse rate from 0 to 4 were classed as having tension of the sympathetic type, those with a decrease from 5 to 9, as normal, and those with a decrease from 10 to 15, as having tension of the parasympathetic type. Of the 40 men who were chronically seasick, 24 were found to be in the first class and 16 in the third. The 6 men who were seaworthy were all in the second class. Of the remaining 428 of the battalion, 327 were normal, in the second class, and 101 were in the third class. Judging from this test, it may be said that all persons with tension of the sympathetic type are subject to seasickness, but that only some with tension of the parasympathetic type are apt to get seasickness. Twelve of the 24 with the tension of the sympathetic type and 8 of the 16 with tension of the parasympathetic type were given 40 cc of 5 per cent solution of sodium bicarbonate intravenously. Then these 40 men and the 6 seaworthy, together with the rest of the battalion, were exposed to the hardships of a long boat trip in a very heavy storm. Most of the men aboard became extremely seasick, even those who considered themselves seaworthy. But all the 20 men who received the injections remained well, took meals as usual and helped take care of the sick.

Another interesting observation was made when a young man aged 22, who was dying of nasal sarcoma, was given 40 cc of 5 per cent solution of sodium bicarbonate intravenously. He died two weeks later, and histologic section showed that the otolithic crystals had been dissolved.

CONCLUSION

Sodium bicarbonate injected intravenously can prevent motion sickness from occurring in man, probably by dissolving the otolithic crystals. It is also suggested that this injection may possibly be of value in Menière's disease.

PENICILLIN IN CHRONIC OTITIS MEDIA

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DURING the time that penicillin was first being used in the treatment of practically any and all types of infections, it was felt that it would be desirable to determine exactly what might be expected from the sole use of this new antibiotic agent in the treatment of chronic otitis media. After the initial experimental stages had given a fairly accurate estimate of the value of the drug against the various acute infectious diseases, it was pretty generally agreed among otologists that penicillin was a substance of real merit in the treatment of acute otitis media and its many complications. This is now an established fact.

The management of the chronically discharging ear has varied greatly over the years. Experience with a succession of nonsurgical methods has been inconsistent and left much to be desired in the way of end results. Although it was realized that the conditions which obtain in chronic disease of the middle ear differ in several ways from those in acute infection, it was considered that a controlled study would be advisable. Hence a study of the systemic use of penicillin was started. To obtain a group of patients with chronically discharging ears hospitalized under control for a sufficient length of time and with adequate dosage of penicillin to provide an estimate of the usefulness of the drug, this study was made in a military hospital.

A total of 82 patients were treated according to a rather rigid and set type of regimen. Unfortunately, when the final charts were being assembled for the statistical survey it was found that many were missing, the patients having been transferred for various reasons or discharged from the service and their charts forwarded to the proper agency. It is felt, however, that the 40 cases for which data were available provide a representative picture of the group as a whole.

The patients were selected from otolaryngologic patients seen routinely in the clinic of a large general hospital. Patients with obvious surgical conditions, such as cholesteatoma or definite destruction of bone, or with complications were not considered for penicillin therapy. A minimum time requirement of two months was set before the condition was considered to be chronic. This period might be considered

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short, but it was felt that such a condition could no longer be classed as acute. The longest period of discharge in these cases was twenty-nine years. The hearing in each case was recorded by both an audiometric study and use of the whispered and the spoken voice. At the time of this survey, use of the whispered voice was the method of choice. Unfortunately, since the patients were a more or less transient group, it was next to impossible to get an accurate follow-up of the hearing over a prolonged period. The type of perforation was recorded. Some marginal perforations were included, even though it was realized that these are sometimes considered to be an indication for surgical treatment. The results obtained in cases of marginal perforation would seem to confirm this opinion. The duration and type of discharge were noted in each case and also whether the discharge had been continuous or intermittent. It was felt, however, that a number of cases in which there was a history of an intermittently discharging ear should be placed in the continuous class, since the ears had never been completely dry. The patient usually described the ear as dry during that period in which the discharge was not actually draining from the auditory canal or was not spotting the pillow at night. The organisms cultured were found to correspond to those isolated in similar groups of patients with chronic otitis which have been reported many times in the literature. Studies of sensitivity of the organisms and determinations of penicillin levels were done in many of the cases. Unfortunately, since the hospital was running at peak capacity, laboratory facilities did not permit the carrying out of these studies in all cases. Undoubtedly, sensitivity studies in each case would have been of value in estimating the expected result. The therapy which had been used previously in these cases varied widely, including all the methods and drugs which had been in vogue in recent years.

Roentgen studies were made but were found to be of limited value in the interpretation of the results to be expected from treatment. Serial roentgenograms were made in the first cases to be studied, and, for the most part, they showed no change either during or following chemotherapy.

The dosage of penicillin remained constant throughout the treatment period in each case. Twenty-five thousand units of the sodium salt was injected every three hours, day and night. It was fortunate that in no case did a reaction occur of a serious enough nature to cause discontinuance of the drug. This was an interesting sidelight in view of the known impurities in the manufactured product at that time. To my knowledge, this was one of the first attempts to give the drug in what was then considered a massive dose over so prolonged a period. Ten thousand to 15,000 units every three or even every four hours was considered to be the optimum dose at that time. It was because of

the known rapid fall of the penicillin concentration in the urine during the third hour that this larger dose was considered preferable. It was also determined at this time that the resistance of certain organisms to the drug might increase as therapy progressed, and this was the first indication that the dosage schedule, even in the treatment of acute otitis, should not be decreased or "tapered off" as clinical improvement was shown. Decreasing the dose was the method accepted by most physicians in 1942 and 1943. In the light of present day knowledge it is felt that if the dosage were doubled or even tripled clinical results might be further improved.

All patients were allowed ward privileges and a regular diet. No other local or systemic medication was given. The ears were cleansed and inspected twice each week, and any progress noted. Patients were visited on ward rounds each day.

Results were classified as "no results" if there was no obvious change either during or following the treatment, "fair" if there was slight but definite lessening of the amount of discharge and the improvement was maintained, "good" if there was definite clinical improvement as determined by almost complete cessation of the discharge and in some cases, by improved hearing. The patients became aware of this improvement during the follow-up period of two months. If there was a return to the former clinical status, the results were then classified as either "no results" or "fair." "Excellent" was reserved for those cases in which the ear became perfectly dry and remained so, hearing at times improved, and in some of the cases there was closure of the perforate tympanic membrane. The minimum observation period was two months, and the maximum was two years.

For the forty-one ears treated the results compiled were as follows: no results, 11; fair, 6; good, 8; and excellent, 16. Interpreted in terms of percentage, the "no results" and "fair" groups made up 41 per cent of the total and the "good" and "excellent" groups 59 per cent. The "excellent" group alone accounted for 39 per cent of the total. Further interpretation of the various groups revealed that in the "no results" group there were three marginal perforations, five central, one antero-inferior, one anterosuperior and one posteroinferior. The last three could readily be classed with the five central perforations. It is interesting to note that among the entire group of forty-one ears all but one of the marginal perforations fell into the "no results" group. This one exception on culture revealed a pure strain of coagulase-positive hemolytic *Staphylococcus aureus* and also was just inside the minimum time interval of two months. It was concluded from this fact that the drug was probably of no benefit in case of marginal perforations of long standing. Nothing definite in regard to the cultures in this group could be distinguished except that in a majority of the cases as one would

expect, *Proteus vulgaris* was isolated. It was noteworthy that in this group there were several cases in which the primary organism had been a hemolytic streptococcus which had not responded to previous therapy, whereas in the other groups a response was obtained. Nothing remarkable was noted in regard to previous therapy in this group except that in no instance could it be considered that adequate antibiotic or chemotherapy had been given, this was true also of the other groups. The roentgenologic findings were noncontributory.

Results for six ears were listed as "fair." Of the six, four were listed as having central perforations, and two had perforations of the pars flaccida. The duration of aural discharge had been from five months to three years. In this group a significant feature was that five out of the six were of the continuous drainage classification. As in the first group, interpretations of the roentgenograms were of little aid. Four of the six had had previous therapy with one or more of the sulfonamide drugs, without improvement.

Results for eight ears were classified as "good." Six of the eight were found to have central perforations, one perforation was marginal, and one was not recorded. The duration of aural discharge varied from two months to five years. In six of the eight the duration of otorrhea had been of less than eighteen months' duration and in the remaining two of four and five years' duration. Seven of the discharges were classed as being of the continuous purulent type. Cultures revealed a gamma streptococcus as the predominant organism in three ears and *Staph aureus* in two. Peculiarly, one of the ears from which a gamma streptococcus was isolated had had previous antibiotic treatment with penicillin intramuscularly every three hours for fourteen days with no results. It was impossible to learn the number of units given in each dose. This may have had something to do with the poor result or, as recently discovered, the streptococcus may have become sensitive with the growth of allied organisms.

In sixteen of the ears results were classed as "excellent." The duration of the otorrhea varied from three months to twenty-six years. Of the sixteen ears, only four were classed as having discharged for one year or less. It is notable that in this group all perforations were of the so-called "central" type, with no involvement of the margin or the pars flaccida. Of the discharges, ten were of the intermittent variety, four continuous and two not classified. The fact that almost two thirds of the discharges in this group were of the intermittent variety brought up the question whether the excellent results might represent just another period of remission or quiescence. However, several of the patients were followed for periods up to two years and there was no evidence of recurrence. It would have been of interest to follow this group especially for a much longer period to see what the rate of

Summary of Data on Forty Cases of Chronic Suppurative Otitis Media

Case No	Hearing	Ear Involved	Type of Perforation	Discharge		Organisms Cultured	Previous Therapy	Roentgen Findings	Total Dose of Penicillin, Million Units	Results*
				Duration	Type					
1	L 7/15	Left	Posterior inferior margin	29 yr	Profuse intermittent	P vulgaris, Staph albus, gamma streptococcus	Alcohol, sulfonamides, irrigations	Sclerosis, no visible cells	4	N
2	R 6/15	Right	Large central	23 mo	Moderate mucopurulent, continuous	Hemolytic Staph aureus, coagulase positive, Ps aeruginosa, diptheroids	Sulfonamides for 2 weeks	Poorly defined cells, no destruction, moderate sclerosis	4.5	F
3	L 5/15	Left	Posterior superior margin	18 mo	Slight purulent	Shigella sonnei	Sulfonamides for 2 weeks, irrigations	No cell outlines, dense sclerosis	4	N
4	R 7/15 L 12/15	Both	Large central	4 mo	Profuse purulent, continuous	P vulgaris (E), Neisseria catarrhalis, diptheroids (L)	Sulfonamides, daily care	No destruction, poor development, left, few cells, right, none	3.8	Left N Right E
5	R 6/15	Right	Anterior inferior	4 mo	Moderate purulent, continuous	Beta streptococcus, Ps aeruginosa	Alcohol, sulfonamides by mouth, penicillin for 5 days	Poor development, cloudy, pneumatic, no destruction	4	N
6	R 1/15	Right	Small central	16 mo	Moderate purulent, continuous	Hemolytic Staph aureus, coagulase positive, gamma streptococcus	Not known	Very cloudy, no decalcification, no destruction	4	E
7	R 15/15	Right	Small posterior margin	2 mo	Slight suppuration, continuous	Hemolytic Staph aureus, coagulase positive	None	Poor development, poor cell structure, slight sclerosis	4	G
8	L 6/15	Left	Anterior superior	3 mo	Slight suppuration, continuous	Beta streptococcus, P vulgaris	None	Little cellular structure of diploe, severe sclerosis	4.875	N
9	R 7/15	Right	Moderate posterior inferior	15 yr	Moderate purulent, intermittent	Gamma streptococcus, Staph albus	Ear drops, sulfonamides orally and locally	Poor development, sclerotic, slightly enlarged antrum	4	E
10	L 3/15	Left	Moderate central	2 yr	Moderate purulent, intermittent	Alpha streptococcus, Ps aeruginosa	Local	Chronic progressive sclerosis	4	E
11	R 13/15	Right	Small posterior	1 yr	Moderate purulent, intermittent	Alpha streptococcus, Ps aeruginosa	Penicillin orally, locally 3 days	Small, poorly developed, cloudy, antrum enlarged	4	E
12	Both 15/15	Right	Anterior inferior	5 mo	Continuous purulent	P vulgaris	Sulfadiazine orally, amount not known	Cloudy mastoid, no evidence of destruction	3	E
13	Both 15/15	Right	Large central	16 yr	Purulent, intermittent continuous for 4 mo	Staph albus, P vulgaris	Boric acid and alcohol drops	Not available	3.6	E
14	L 6/15	Left	Small, shrapnel	3 yr	Purulent, continuous	Aspergillus glaucus, P vulgaris	Sulfadiazine orally 12 days	Absence of cell development	4.15	I
15	Both 15/15	Both	Large central	4 mo	Purulent, continuous	Not known	Sulfonamides orally	Evidence of bilateral breakdown of cells	3.6	N
16	R 15/15	Right	Moderate anterior inferior	17 yr	Purulent, intermittent	Hemolytic Staph aureus, coagulase positive	Boric acid and alcohol drops	Sclerosis, few cells, slightly enlarged antrum	4	E
17	L 6/15	Left	Small, shrapnel	Unknown	Seropurulent, continuous	A glaucus	Not known	Sinuses poorly developed, sclerotic	4.2	G
18	R 15/15	Right	Small posterior central	10 yr	Foul purulent, intermittent	Alpha streptococcus, P vulgaris	Boric acid and alcohol drops	Diploe periantral sclerosis	3.8	E
19	L 14/15	Left	Large central	18 mo	Foul purulent, continuous	P vulgaris, diptheroids	Penicillin intramuscularly 7 days, boric acid drops	Poor development, sclerotic irregular antrum	4	G
20	L 2/15	Left	Large central, traumatic	7 mo	Profuse purulent, continuous	Staph albus, gamma streptococcus, Aerobacter aerogenes	None	Cloudy, well developed calcified septums near sinus knee	3.8	G
21	L 1/15	Left	Large posterior margin	2 yr	Moderate purulent, intermittent	Beta streptococcus, P vulgaris	None	Poor development, slight cloudiness, no destruction	4.475	N

	22	R 13/15	Right	Posterior inferior	4 yr	Moderate purulent, intermittent	Alpha streptococcus A aerogenes	None	Not available	4 760	E
	23	R 15/15	Both	Moderate posterior central	5 mo	Mucopurulent, continuous	Staph albus, P vulgaris	Penicillin intramuscularly 3 days, sulfadiazine 7 days	Slightly thick cell walls, moderate sclerosis	4	N
	24	L 5/15	Left	Large oval central	26 yr	Thick purulent, intermittent	Not known	Boric acid and alcohol drops	Sclerotic with very few cells	4	E
	25	L 13/15	Left	Large inferior central	5 mo	Thick purulent, continuous	A aerogenes, diphtheroids	Sulfonamides orally, alcohol drops	Diploic marked periantral sclerosis	4	F
	26	Both 15/15	Right	Moderate central inferior	18 mo	Purulent, continuous	Hemolytic Staph aureus, coagulase positive	Sulfonamides orally 1 month and later 2 weeks	Sclerosis with few visible air cells	4	F
	27	R 12/15	Right	Moderate, shrapnel	10 mo	Purulent, recurrent	Not known	Attic lavage, alcohol drops	Moderate sclerosis, moderate thick cell walls	4	E
	28	R 2/15	Right	Moderate central	15 yr	Purulent, intermittent, 5 mo continuous	Anaerobic beta streptococcus	Sulfonamides orally, alcohol drops	Sinuses poorly developed, slightly cloudy, slight sclerosis	3 8	HE
	29	L 0/15	Left	Large central	7 mo	Mucopurulent, continuous	Hemolytic Staph aureus, coagulase negative	Sulfonamides orally, penicillin locally	Sclerotic, slightly irregular antrum	3	N
	30	R 10/15	Right	Moderate anterior central	3 mo	Thin purulent	Beta streptococcus, Ps aeruginosa	Sulfonamide powder, alcohol drops	Slight clouding of cells, no destruction	3 5	HE
	31	L 3/15	Left	Moderate central	2 mo	Profuse purulent	Ps aeruginosa overgrown	None	Moderate clouding, no destruction	4	N
	32	Both 15/15	Left	Moderate posterior central	16 yr intermittent, 5 yr continuous	Purulent	Hemolytic streptococcus, hemolytic Staph aureus	Penicillin intramuscularly 3 days	Poor development, slight clouding, antrum enlarged	4	E
	33	Both 10/15	Left	Moderate posterior central, due to bomb blast	6 mo	Purulent, continuous	Gamma streptococcus, Ps aeruginosa	Syringing	Cells slightly cloudy, no destruction	4	F
	34	R 3/15 L 6/15	Both	Large central (bilateral)	L 15 yr R 6 mo	Purulent, intermittent (left), continuous (right)	P vulgaris, Ps aeruginosa (bilateral)	Penicillin intramuscularly 4 days, local drops	Moderate sclerosis, no destruction, enlarged antrums	4	N
	35	Both 15/15	Right	Posterior central, traumatic	5 mo	Purulent, hemorrhagic, continuous	Beta streptococcus, Ps aeruginosa	Sulfonamides locally, alcohol drops	Sinuses well developed, slight clouding, slight decalcification	3	HE
	36	L 10/15	Left	Moderate central	1 yr	Purulent, intermittent	Hemolytic Staph aureus	"Listerine" (antiseptic solution N F) drops, ultra violet rays	Very sclerotic, antrum enlarged	4	E
	37	Both 15/15	Left	Small posterior inferior	3 yr	Purulent, continuous	Staph albus, A fecalis	Sulfonamides locally, cleaning	Well developed, cloudy, no destruction	3 6	E
	38	R 8/15	Left	Large central	6 mo	Purulent, continuous	Gamma streptococcus, Ps aeruginosa	Penicillin every 3 hours for 14 days, sulfonamide powder	Poor development, slight clouding, no destruction	3 6	F
	39	R 14/15	Right	Small anterior inferior	5 yr intermittent, 1 yr continuous	Purulent	Hemolytic Staph aureus, coagulase positive	Powder, hydrogen peroxide, alcohol drops	Moderate sclerosis, no destruction	4	F
	40	R 12/15	Right	Moderate central	4 yr	Purulent, continuous	Gamma streptococcus	Sulfonamides orally 7 days	Moderate sclerosis, slightly enlarged antrum	4	F

* N Indicates no results, F, fair results, G, good results, F, excellent results, HE, healed membrane excellent results

recurrent otorrhea would be. The bacteriologic findings were interesting in that from fourteen of the sixteen ears a streptococcus or a staphylococcus, or both, presumably sensitive to penicillin, were cultured. One ear was reported to have yielded a pure culture of *Proteus vulgaris* and yet responded to therapy. In this group there is also noted a large number of ears with secondary invaders, five with *Pseudomonas aeruginosa*, four with *P. vulgaris* and one with *fecalis*. None of these organisms are sensitive to penicillin. It is difficult to explain the cessation of discharge in view of this known fact. Perhaps it was because of the thorough cleaning given each ear at the time of inspection. Had local therapy been used in conjunction with the antibiotic agent it is felt that the percentage of good or excellent results might have been higher.

It has been noted that when there is traumatic perforation of the tympanic membrane accompanied with infection, the tendency of the membrane to heal is greater. Three tympanic membranes in this group were healed, and in each of these the culture revealed the beta streptococcus as the primary organism. In this group alone it was felt that the roentgenograms might have been of some aid, as each of the three showed either no sclerosis or clouding or only slight sclerosis and mild clouding.

SUMMARY

Penicillin given intramuscularly over a prolonged period was found to be of definite value in the treatment of certain cases of chronic otitis media. Ears with chronic discharge ranging from two months to twenty-nine years' duration have remained dry for as long as two years following treatment. In a small percentage of cases there was not only cessation of the otorrhea but healing of the tympanic membrane. Penicillin was not given to supplant surgery in the treatment of chronic otitis, however, in this selected group of patients it was found to give a greater than 50 per cent chance of obtaining a dry ear and maintaining it for two years or longer.

My later experience with the use of penicillin locally in cases of chronic otitis media would indicate that a higher per cent of good results may be obtained from the combined use of this antibiotic drug.

Further study of the use of antibiotics in chronic diseases of the ear is indicated to determine the degree of return of hearing and also the rate of recurrence when followed over a period of years.

CONCLUSIONS

- 1 The intramuscular use of penicillin alone offers a better than 50 per cent prospect of obtaining a dry ear in the treatment of selected cases of chronic otitis media.

- 2 It is of doubtful or no value in the group of so-called marginal perforations.

3' One cannot expect as good results when it is used in those cases in which the discharge from the external canal is interpreted as continuous

4 Best results from the use of penicillin will be obtained in the central type of tympanic perforation and also in cases in which there has been otorrhea for less than eighteen months

5 When used in cases in which the predominant organism is the beta streptococcus the membrum tympani will have a greater tendency to heal

6 Roentgen examination is not helpful in the selection of cases with possibly one exception, when little sclerosis is shown, the chances of a good end result are greater

615 Anderson Bank Building

MANAGEMENT OF ACUTE LARYNGOTRACHEOBRONCHITIS

JOHN R. SIMPSON, M.D.
PITTSBURGH

IN 1908, Chevalier Jackson directed the attention of the physicians of America to a disease entity which has come to be known as acute laryngotracheobronchitis. As a pioneer in endoscopy, Jackson was afforded the opportunity of viewing through the bronchoscope the nonmembranous character of this disease as it affected the larynx, trachea and bronchi in a number of children who appeared clinically to have diphtheria. He described the pathology as differing from that of diphtheria in that the mucosa was more edematous and the secretion thick and tenacious, tending to form crusts and plugs and often leading to atelectasis and death.

The disease in its severest form was observed most frequently in children under 3 years of age, whose air passages are actually, as well as relatively, smaller than those of older children. When a normally small airway was attacked by an inflammation characterized by swelling of the loose subglottic tissue and the formation and accumulation of thick, gummy, glue-like secretion, with absence of the cough reflex, one could easily understand the degree of obstruction to the passage of air to the lungs in many of these patients.

Without the help of drugs of specific action, treatment was limited to supportive measures and to efforts directed toward maintaining a free airway. These, in the main, consisted of (a) forcing of fluids and addition of moisture to the inspired air, (b) bronchoscopy, with suction and removal of plugs with forceps, (c) tracheotomy, (d) suction with a soft rubber catheter passed through a tracheal cannula, and (e) dropping of solution into the trachea, followed by suction.

It was hoped that if the airway could be maintained for a time the defensive forces of the body would become active and overcome the infection. Very often these measures were not adequate, and it was not surprising that published reports of such cases revealed a mortality rate of 50 per cent or higher. Actually, the mortality rate of all such cases throughout the country must have been much higher, for hundreds of cases were never reported.

Read before the Section on Laryngology, Otology and Rhinology at the Ninety-Seventh Annual Session of the American Medical Association, Chicago, June 24, 1948

In recent years, or since the introduction of antibiotic drugs, the few published reports show a considerable drop in the mortality rate. In spite of these favorable reports, the disease in its severe fulminating form has not been brought under control in all cases. Certainly, the experience that we at Children's Hospital have had with cases of laryngotracheobronchitis has not been entirely satisfactory, as the following report will show.

This report does not include all these cases, only those occurring during an eight year period, from 1940 to 1947, inclusive, in which a tracheotomy was required. It may be assumed that nearly all of the patients who did not require operation lived. The histories of 10 of 12 patients in whom the condition was fatal were reviewed for the purpose of determining the cause of death. Postoperative accident was the

Cases of Tracheotomy

Year	Number	Deaths
1940	12	2
1941	6	1
1942	8	2
1943	7	0
1944	18	4
1945	8	0
1946	2	0
1947	3	3
Totals	64	12
Mortality rate		18 + %

cause of death in 1, bronchial obstruction, atelectasis and pneumonia in 2, bronchial obstruction in 3, pneumonia in 2, and emphysema and pneumothorax in 2. Seven of the 10 patients died within one day after admission to the hospital, 72 per cent of the patients were under 2 years. This review of a small number of cases points to bronchial obstruction as the most frequent cause of death.

Tracheotomy alone, or combined with bronchoscopy, with removal of plugs with forceps and suction, will not always clear the airway sufficiently to permit an adequate supply of oxygen to reach the lungs. In our experience, obstruction has been the chief obstacle to successful treatment. It has been suggested to us that the lungs be by-passed for a time by the introduction of oxygen into the vessels. So far we have not had the courage to attempt this. Perhaps we are omitting some important step in our treatment. In order that the members may know what measures have been employed, the remainder of the paper will be devoted to their discussion.

MATERIAL AND METHODS

On admission to the hospital, the child is placed in a tented crib supplied with moisture and oxygen and given an injection of penicillin. If he is badly in need of oxygen, he is placed in an oxygen tent while preparations are being made for tracheotomy. In the event that the child rallies quickly, operation is deferred and he is transferred to the tented crib and watched. If the improved condition continues, he is kept in the crib.

Humidified air has long been considered helpful in the treatment of this condition, but the manner of its administration has not always been satisfactory. The old-fashioned croup kettle is not suitable for these cases, too much time is lost in getting up the steam, besides, the room or the enclosure becomes unbearably warm. Humidifiers placed in a room have not been entirely satisfactory. Their action also is too slow, their motors get out of order, pools of water collect on the floor, and electrical connections make the work of the nurses hazardous.

The setup that we have been using for three or four years, and find very satisfactory, consists of a draped crib into which water and oxygen are sprayed, it has the following advantages:

- 1 The equipment is quickly set up, and in a few minutes an adequate amount of moisture mixed with oxygen is delivered to the patient.
- 2 It does not get out of order.
- 3 There are no electrical connections.
- 4 The air in the tent is kept cool, 70 to 75 F.
- 5 The amount of oxygen is sufficient for the need in most cases, 25 to 40 per cent by volume.
- 6 Additional oxygen or oxygen and helium can be supplied directly to the tracheal cannula, if needed.

We believe that since the use of this setup the tendency toward formation of bronchial plugs has been lessened and that it has been an important factor in reducing the number of cases in which a tracheotomy would be required.

This setup has been well received by the pediatricians of our hospital, as many as seven sets having been seen in operation at one time. While we believe that we have found a satisfactory method of supplying moisture, so essential in counteracting the formation of crusts and plugs, it must always be kept in mind that it is the amount of oxygen that reaches the alveoli of the lungs that is important, rather than the amount flowing into the tent.

In most cases, the amount of oxygen being delivered to the patient will be adequate. The plastic canopy draped over the top of the crib is allowed to hang free at the bottom to permit a free exchange with the air in the room. If this precaution is observed, the accumulation of carbon dioxide in the tent will be negligible.

Dr. John Rathbun, the chief resident at Children's Hospital, is having a small compartment fitted into the tent which, it is believed, will make it possible to add the use of penicillin mist to the present method of administering humidified oxygen. Penicillin in this form has been used in a few cases with good effect.

It takes an experienced observer, one who has spent many hours at the bedside of these patients, to appraise their condition. Even then, his judgment may be faulty. Determinations of the oxygen content of arterial blood may be helpful. Unless the respiratory rate is decreasing, the color of the child is improving, there is less tugging and the child is able to rest comfortably, he may be slipping into a dangerous state of anoxia, so well described by Galloway.

Drugs—Without the aid of present day drugs, the mortality rate would still be high, and so it is important that they be used promptly and in adequate dosage.

Penicillin is our first choice, alone or with sulfadiazine. Streptomycin has been added in a few cases in which an influenzal infection was suspected. Jackson has cautioned against the use of atropine and codeine. Phenobarbital has occasionally been used.

Hydriodic acid syrup given late in the disease seems to help in thinning the secretion.

Tracheotomy—Except at the hands of a few experts, tracheotomy on a small child is a hazardous procedure. Any one considering a tracheotomy should read Neffson's article¹. It would be well to give heed to his list of indications for tracheotomy, and to his caution against too much dissection. Neffson's assertion that audible stridor is not always an indication for tracheotomy tallies with our experience. With regard to stridor, Neffson stated: "It was when the stridor became 'muffled,' aphonic, that we began to worry, because it meant that the airway was becoming narrowed by edema or secretion or membrane or a combination of them."¹ He lists his indications for tracheotomy as follows:

"Signs of extreme obstruction

Restlessness

Cyanosis—pallor

Deep retractions

Absence of breath sounds

Anxious facies

Signs of exhaustion

Tachycardia, impalpable pulse, heart failure

Tachypnea—rapid, shallow breathing

Hyperpyrexia—from 105 to 107 F

Stupor, coma, convulsions"

Technic in the performance of tracheotomy is very important. Usually, the child's condition is desperate, and there is a tendency, therefore, to hurry the operation. The tracheotomy will be greatly facilitated by the passage, first, of a small bronchoscope or, if one lacks experience in bronchoscopy, of a Mosher life-saving tube. Through the bronchoscope, secretion may be suctioned, thus clearing the airway for the admission of oxygen if needed during the operation. This preliminary step will enable the operator to work more leisurely, with the patient under local anesthesia, very little dissection will be necessary because the trachea is held fixed in the midline and nearer the surface. Dissection of the cricoid cartilage must be avoided, and Neffson warned against stripping the pretracheal fascia so that air might be permitted to enter the chest.

Postoperative Care—After-care when tracheotomy is performed is as important as the tracheotomy itself. After a satisfactory airway has been established, the next problem is to prevent its later obstruction by secretion drying and accumulating in the trachea and bronchi. To combat such a tendency, it is very important to have a nurse specially trained in this work constantly at the patient's bedside. No one appreciates better than she the importance of changing the inner cannula when it becomes plugged, aspirating secretions to maintain a free flow of air, forcing liquids, and maintaining a high degree of humidity and oxygen in the crib at all times.

¹ Neffson, A. H. Tracheotomy in Cases of Acute Obstructive Nondiphtheritic Infections of Larynx, Trachea and Bronchi. General Study, with an Analysis of One Hundred and Twenty-Six Consecutive Cases Occurring During the Past Decade, Arch. Otolaryng. 36:773 (Dec.) 1942.

Members of the profession whose work is confined largely to laryngology and endoscopy have an advantage in this respect. Other physicians often have to rely on the good judgment of a head nurse to direct properly and to supervise closely an inexperienced student nurse, rather than to engage a graduate nurse without experience who will not accept advice. Such an arrangement will require close vigil on the part of the physician, a not uncommon experience for him during these latter years.

Attention to details is important, and, if observed, all but a few patients will be brought safely through a disease in which the death rate was formerly high.

CONCLUSION

The measures outlined in this paper, when used early and adequately, have proved effective in greatly reducing the mortality rate in cases of acute laryngotracheobronchitis. These measures represent a pooling of the experiences of many of our colleagues.

It is hoped that the discussion which follows will tell us how to handle the not so rare fulminating type, which remains an unsolved problem.

409 Medical Arts Building

ABSTRACT OF DISCUSSION

DR. L. H. CLERF, Philadelphia. At the clinic with which I am associated, there are not as many cases of acute laryngotracheobronchitis now as there were ten or fifteen years ago, the infection does not appear so severe, tracheotomy is required less frequently and the mortality rate is low. Also, the condition now is more often seen earlier, and this is an important factor in treatment and in end results.

The plan of therapy at my clinic differs little from that presented by Dr. Simpson. With the consideration of diphtheria and a foreign body as diagnostic possibilities, penicillin therapy is started, and the patient is placed in a cool, humidified atmosphere to which oxygen is added. An adequate fluid intake is maintained. If dyspnea is severe on the patient's admission, or if dyspnea progresses in spite of therapy, tracheotomy is performed without delay. It is a mistake to defer tracheotomy and consider it as a last resort. When tracheotomy has been performed, one must not wait for laryngeal obstruction. The nurse should change the inner cannula at stated intervals, even when no apparent obstruction exists. In addition, isotonic sodium chloride solution, with or without penicillin, should be instilled at stated intervals to prevent crusting of secretions. Suction with catheter should be employed only if the child is unable to cough up the solution and secretions. Trauma to the tracheal mucosa, with bleeding induced by the catheter suction, increases the tendency toward crusting.

In connection with tracheotomy, I wish to emphasize the importance of leaving the wound open. Too many violate the important surgical principle never to close infected wounds and to sew the skin snugly around the cannula.

Humidification is extremely important. Dr. Simpson's method is an ingenious and an excellent one. I do not consider it necessary to maintain a humidity of 90 to 100 per cent. One can get a humidity of about 70 per cent in an oxygen tent in the presence of a cool atmosphere, and that seems adequate. I have discussed with representatives of manufacturers of oxygen tents the desirability of installing

an auxiliary aid for humidification, which would simplify the problem immeasurably. Too often nurses are not competent to operate an assortment of gadgets, and, from an economic standpoint, patients often cannot have physicians, nurses and maintenance men in attendance.

I wish to compliment Dr. Simpson on the excellence of his presentation.

DR. PAUL H. HOLINGER, Chicago: Acute laryngotracheobronchitis continues to be one of the urgent medical emergencies. Proper management depends on the cooperative efforts of the pediatrician, the laryngologist and the resident staff. As Dr. Simpson has mentioned, the nursing care of infants in whom laryngotracheobronchitis is developing is almost a specialty in itself.

Dr. Simpson has pointed out that the introduction of antibiotic drugs has been followed by a decided drop in the mortality rate. These agents are now so continuously used by the pediatrician at the onset of the infection that the incidence may appear to be diminishing. However, as he mentioned, the not so rare fulminating type of case remains a difficult problem. This disease constitutes a medical emergency and is treated as such. At the Children's Memorial Hospital, admission routine is by-passed, the infant is placed immediately in the "steam room" and chemotherapy is started at once. Both penicillin and sulfathiazole are administered and administrations continued until the throat cultures indicate that one or the other of these agents is no longer necessary. Streptomycin is used in addition in the more fulminating cases in which the influenzal organism is often found to be the causative agent. My associates and I have found the sulfonamide drugs much more effective than penicillin and have often noted a favorable response following their administration when penicillin alone had been used without appreciable benefit. This use, obviously, is dependent on the causative organism.

Dr. Simpson has devised a unique method of supplying humidity. Humidity is second in importance to chemotherapy in the management of acute laryngotracheobronchitis. We still prefer the mechanically humidified rooms for this purpose, with the room temperature between 70 and 75 F and the relative humidity above 90 per cent. The rooms set aside specifically for this purpose are rarely idle. One wonders whether the relative humidity in the tents can be kept this high when they have to be opened frequently for necessary nursing care. With adequate humidity, deaths due to bronchial obstruction, the most frequent cause in the cases reported, should be almost completely eliminated.

We agree with Dr. Simpson that if surgical relief for respiratory obstruction becomes necessary, bronchoscopic aspiration and tracheotomy with the bronchoscope in place are the methods of choice. Intubation in too many instances is not satisfactory. The reports in the recent literature that tracheotomy with a bronchoscope in place is followed by mediastinal emphysema and pneumothorax are provocative of further investigation and discussion. We feel that these complications, when they arise with the use of this technic, are due to too low a tracheotomy, since the hyperextended position of the head draws the thoracic portion of the trachea well up into the neck. Then, as the bronchoscope is withdrawn and the head returns to its normal position, the tracheal incision lies within the thorax. Subsequent coughing forces the air into the mediastinum or the pleural cavity.

The tent Dr. Simpson has devised seems most ingenious and, possibly, with the addition of penicillin mist, may have certain advantages. I should like to ask him whether he has carried on humidity readings in the tent and whether he feels that the tent can be kept sufficiently closed during nursing and aspirations through the tracheotomy tube to keep the humidity from dropping. We believe that a special room mechanically humidified permits a more constant, higher humidification and thus is more likely to prevent the formation of bronchial plugs.

DR GABRIEL TUCKER, Philadelphia Certainly, my associates and I agree with Dr Simpson and the discussers that the tracheotomy should not be delayed For the past three or four years we have used a special technic for the insertion of the bronchoscope, that of putting a pack, in which we use antibiotics, penicillin or powdered sulfanilamide, around the tube We have had no cases of infection of the neck, and no cases of emphysema The prevention of these complications is most important We have a method by which these complications are practically one hundred per cent avoidable I believe the method is not in general use, but my associates at the University of Pennsylvania, Dr Atkins and Dr Lee, have used it in hospitals with which they are associated It enables one to make a very short incision in the neck, one does not expose the whole front of the neck or get down into the mediastinum The incision is made just large enough to expose the trachea, then a short incision is made in the trachea itself Then, if a pack is placed in this incision and the tube tied tightly around the neck, emphysema or infection will be prevented by the antibiotics impregnated in the pack The tube is wrapped with narrow gauze impregnated with either sulfanilamide or penicillin, and a practically clean wound results

DR THOMAS GALLOWAY, Chicago I should like to emphasize the place of postural drainage in treatment Dr Simpson has the patient lie flat during drainage I think this is a grave mistake Since my associates and I have used postural drainage with irrigation, we practically never do a bronchoscopy At least a 20 degree angle is necessary to achieve postural drainage This is the normal declivity of the trachea and bronchi from the body axis In order to get postural drainage, the body must be elevated at least 25 degrees, and this is seldom done With this elevation, and with the use of 3 per cent solution of sodium bicarbonate through the tracheotomy tube to loosen mucus and plugs, followed by isotonic sodium chloride solution, bronchoscopy to remove crusts and plugs will seldom have to be done

The Walton mechanical humidifier, in which a tube is led up into a croup tent, provides excellent humidification, we have seen repeatedly, in cases in which this humidifier had not been used previously but had been instituted, that the crusting completely disappeared

The antibiotics are indicated, but the mechanical factors are very important Some of these infections undoubtedly are caused by a virus

We have now had 15 consecutive cases at the Evanston Hospital without a death Part of this result is due to better cooperation on the part of other physicians, who realize that any child with beginning obstruction should be hospitalized and should be seen early by a laryngologist We believe that we no longer see many cases of the fulminating type The other factor is recognition of the fact that anoxia and the effects secondary to obstruction with negative intrathoracic pressure very quickly make the condition irreversible, so that when tracheotomy is to be done there must be no delay

DR DAVID DAVIS, Washington, D C Something besides the use of steam and antibiotics, which may or may not be effective, should be done for such children while it is being determined whether a tracheotomy is needed We physicians sometimes fail to do a certain thing which was advocated by Baum several years ago He advised the intravenous use of hypertonic plasma solution I have used it with almost dramatic effect, as though a tracheotomy had been done The administration of about 20 cc of it intravenously to children with this condition will sometimes decrease the edema of the larynx sufficiently to allow better breathing, and a tracheotomy may not have to be done

It is after a tracheotomy that I find most of the trouble arising because nurses are not trained in what to do with the patient. We say to them, "Do this," or "Do that," without actually showing them how to do it.

Those who do not see many children with this condition will sometimes find to their discomfiture that the child is apparently dead on arrival at the hospital. For such occurrences, the nurses have to be shown how to use an aspirator down through the tube. I have seen them put a suction catheter about 2 inches (5 cm.) long into the tube and think they have reached all the way down into the bronchus. They are afraid to go deeper. They have to be shown how far down into each bronchus they need to place the tube and how to turn the tube a little to reach into the various bronchi. Interns are also afraid to use a tube; they think they are going to kill the patient by inserting a rubber tube into the bronchus. I instruct each one individually.

Furthermore, one must listen to the child's chest each time one comes into the room. I never fail to listen to both sides of the chest with a stethoscope each time I come into the room. One side may be atelectatic without there being much difficulty in breathing. If, by any chance, a little of that crust will go to one side the child will die without a chance. I always make sure that both sides are open front and back. It takes hardly any time at all.

Another thing I do, which is probably unorthodox and may or may not be acceptable to most physicians (I have been criticized but so far nothing has happened), is use oil in the bronchus. I use the no. 30 refined peanut oil. I instill it through the tracheotomy tube exactly as is done with a saline solution, but when it gets down I have the nurse insert a fluid and so practically nothing gets into the alveoli. The oil does, however, open up the tracheobronchial tree and soften the crusts much better than either a saline solution or a solution of sodium bicarbonate. I have never seen anything happen to the lung with the use of this oil. Like iodized oil, it should not hurt the trachea, bronchi or lungs. I have used it for several years and have never yet had to do a bronchostomy. It does not have to be used very often, perhaps two or three times a day—and just a few drops enough to run down. I found it to be very successful. I should not suggest using so much of it that it stays down in the lung, but if it is sucked out after its use, there should be no difficulty.

DR JOHN R. SIMPSON, Pittsburgh. The method described of humidifying the air is adequate and can be promptly installed, a minor objection being that pools of water collect on the rubber blanket.

In reply to Dr. Galloway. We have not used his method of drainage routinely. In 1 case, with some loss of use of the muscles of the chest after infantile paralysis, raising the foot of the bed facilitated the expulsion of secretions.

MODERN MANAGEMENT OF OROANTRAL FISTULA

RICHARD THOMAS BARTON, M D
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MANY chronic oroantral fistulas treated in the past could have been prevented had certain steps been taken immediately after their occurrence. There is a necessity for improvement in the manner in which these lesions are managed. It is the purpose therefore, of this paper to outline those modern measures which have proved most successful in the treatment of this condition.

MATERIAL AND METHODS

In the past four years I have treated 41 patients with oroantral fistulas. Of these 12 had so-called acute fistulas and 29 had chronic fistulas. In all but 6 the condition represented the result of extraction of diseased teeth which opened the antral floor. Of these remaining 6 patients, 3 had chronic fistulas caused by a dentigerous cyst eroding into the maxillary sinus. A fourth patient was a Marine lieutenant with a single fistula which resulted from a gunshot wound received in hand to hand fighting at Okinawa, and which was similar to that in the second case reported by Wible and Howard¹. Two perforations followed a Caldwell-Luc operation (radical maxillary sinusotomy). Eight of the patients with chronic fistulas had experienced one or more previous attempts at closure before coming under my care. The methods I have developed for the management of this condition are not original but represent a combination of the better suggestions of many authors together with the use of modern antibiotic drugs.

Acute Oroantral Fistula—This term is used to designate those lesions in which the connection between the mouth and the antrum has been recently established. This condition is usually associated with acute or subacute maxillary sinusitis of some degree.

After a maxillary tooth has been extracted, the signs that the antrum has been entered are (1) bleeding from the nose, (2) escape of air through the socket with expiration, (3) frothing or bubbling of blood in the socket and (4) escape of liquids in the mouth through the nose². If any of these signs occur, or if signs or symptoms of a general toxic state follow, the patient should have the immediate care of a rhinologist.

Presented at the Clinical Congress of the American College of Surgeons, Los Angeles, Oct 21, 1948

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1 Wible, L. E., and Howard, J. C., Jr. Traumatic Palatal Fistula, Arch Otolaryng 44 159-165 (Aug) 1946

2 Berger, A. Oroantral Openings and Their Surgical Corrections, Arch Otolaryng 30 400-410 (Sept) 1939

In this series, as soon as was possible, after the signs appeared, the antrum was washed through the inferior meatus to remove blood and pus. Cultures were made if pus was obtained. Five cubic centimeters of penicillin (5,000 units per cubic centimeter of isotonic sodium chloride solution) was then instilled. Roentgenograms were always taken thereafter. In treatment, care was taken never to curet, probe or pack the socket.³ Irrigation through the fistulous tract was always considered inadvisable. Finally each patient was instructed to avoid blowing his nose.

The fistula was then closed by biting the alveolus away with the rongeur, if necessary, and approximating palatal and buccal mucoperiosteal flaps with mattress sutures.⁴ When possible, a temporary so-called saddle plate of dental composition was made to fit snugly over the sutured area and prevent oral secretions from escaping into the antrum. This plate was designed in the manner described by Strong,⁵ i. e., to lie over the sutured flaps but not in any way to extend into the fistula. The plate was held in place by wires or sutures, arranged according to the location of the fistula and the number of surrounding teeth. The patient was placed on a liquid to soft diet, and mastication was done on the opposite side of the mouth.

If the roentgenograms demonstrated a fragment of tooth or other radiopaque foreign body, the substance was removed from the antrum by a radical maxillary sinusotomy. If, on the other hand, there was evidence that the maxillary sinus had been infected previous to the formation of the fistula, an antral window was made. The sutures and saddle plate were usually taken out on the tenth day. However, some were removed sooner when it was evident that the fistula was closed.

When signs of maxillary sinusitis did not appear after ten days of daily irrigations and instillation of penicillin, no further treatment was considered necessary. If, however, acute sinusitis developed, the instillations were continued along with intramuscular injection of penicillin until the infection was brought under control and the fistula closed. When the fistula closes only partially and continues to drain for three or four weeks, the lesion must be considered chronic and treated accordingly.

Chronic Oroantral Fistula—This term is used to designate those lesions in which the connection between the mouth and the antrum has been long established. In such instances the tract usually has become partially or completely epithelized. The primary problem is the elimination of the sinusitis, inasmuch as it is usually the purulent drainage from the antrum that prevents the fistula from healing spontaneously. However, besides epithelization of the tract and chronic maxillary sinusitis, other factors, such as osteomyelitis of the maxilla or an unusually large bony defect, may occasionally explain the failure of these communications to close spontaneously.

In treatment of chronic oroantral fistulas, the Caldwell-Luc procedure was found to be best suited to accomplish all the necessary measures, namely, removal of the antral infection, removal of the diseased bone or foreign body, removal of the entire epithelial lining of the fistula and correction of the defect in the roof

3 Hall, S. S., and Thomas, H. V. Maxillary Sinusitis of Dental Fracture Origin, *W. Virginia M. J.* **38** 146-155, 1942.

4 Cogswell, W. W. Dental Oral Surgery, Pittsburgh, Dental Digest, Inc., 1932, p. 309.

5 Strong, C. N. Some Considerations of the Pathology and Treatment of Dental Infections of the Antrum, *Proc. Roy. Soc. Med.* **29** 1547-1552, 1936.

of the mouth. Therefore, in order to secure the uniformly best results, this operation was performed and the fistulous lining removed. The defect was closed at the same time by whichever plastic procedure best suited the individual case. This was always done at the same time as the operation on the sinus in order to avoid reinfection of the antrum, although delayed flaps were occasionally employed.

The Caldwell-Luc incision was frequently included in the flap incisions and the entire wound sutured tightly, as described recently by McQuiston.⁶ Care was taken to make the palatal incision medial to and parallel with the greater palatine artery and palatine nerves to preserve the blood supply of the flap. After operation, the antrum was irrigated daily and penicillin instilled thereafter. As this was done gently, and with little pressure through the inferior meatus, the clot and granulations in the fistulous tract were not disrupted. The same precautions were taken as those described for the acute condition, i. e., probing, packing, curetting and irrigating the tract were avoided, and the patient was instructed to avoid blowing his nose.

With patients requiring more extensive plastic repair, a variety of surgical technics may be used, the discussion of which is not within the scope of this paper.

TABLE 1—*Data on 12 Cases of Acute Oroantral Fistula*

	Number of Cases
Lesion	
Simple fistula	9
Fistula with acute sinusitis	3
Location	
First molar	2
Second molar	9
Treatment	
Immediate closure, penicillin irrigations	11
Immediate closure, penicillin irrigations plus nasal antrotomy	1

Many authorities have described their own methods of plastic closure, and the subject has been well reviewed by Major.⁷ Others have added new technics more recently.⁸

RESULTS

With the technic described, uniformly successful results in management of the acute fistulas were obtained in producing primary closure of the oral wound. It should be pointed out that the majority of, but by no means all, the untreated acute fistulas heal spontaneously. However, every one in this series closed, and acute maxillary sinusitis developed in only 3 patients (table 1). These patients had all consulted the rhinologist more than twenty-four hours after the extraction. Antral irrigations

6 McQuiston, R. J. Maxillary Sinusitis of Dental Origin and the Management of Antral Fistula, *Ann Otol, Rhin & Laryng* **54** 373-383, 1945

7 Major, G. Buccoantral Fistula. A Method of Closure, *Arch Otolaryng* **29** 319-325 (Feb.) 1939

8 Proctor, B. The Closure of Oromaxillary Fistulae—A Preliminary Report, *Laryngoscope* **56** 46-47, 1946. Hersh, J. H. Plastic Repair of a Large Alveolar-Antral Fistula, *Arch Otolaryng* **43** 141-142 (Feb.) 1946. Tholen, E. F. Closure of Oral Antral Fistula, *J. Oral Surg* **3** 255-257, 1945

TABLE 2—Data on 29 Cases of Chronic Oroantral Fistula

Lesion	Number of Cases
Fistula with chronic sinusitis	16
Fistula with dentigerous cyst	3
Fistula following Caldwell Luc operation	2
Fistula with foreign body in and osteomyelitis of antrum	1
Fistula with foreign body in antrum	7
Treatment	
Caldwell Luc operation and construction of buccopalatal flap	26
Construction of inferior meatal window	3



Fig 1—Osteomyelitis of the maxilla and oroantral fistula. A complete bony shelf dividing the antrum into two chambers was discovered at operation. The upper cavity was lined with normal mucosa and walled with normal bone. The lower cavity contained a 6 inch (15 cm) piece of iodoform gauze, and the walls were completely absorbed by an osteomyelitic process. The gauze had been acquired during some ill advised dental treatment of the fistula.

and roentgenograms revealed evidence of inflammation at their first visit, indicating that the sinusitis had developed prior to adequate therapy. Even these patients responded satisfactorily when given immediate vigorous treatment.

In 1 case of acute fistula it was thought necessary to construct an inferior meatal window because the patient had waited six days for further consultation. The patient complained of a foul discharge from the nose and the fistula. He had no fever or headache. Washings from the maxillary sinus yielded a large amount of fetid pus. Roentgenograms made after lavage demonstrated considerable thickening of

the mucous membrane of the sinus, this thickening was interpreted as evidence of a preexisting sinusitis of subacute or chronic nature

Treatment of the chronic fistulas resulted in failure in 3 cases. It was believed that treatment failed in 2 cases because an antral window was constructed when a Caldwell-Luc procedure was indicated, owing to chronic, irreversible changes in the mucous membrane. The window was constructed in each case because the patient refused a more radical operation. Treatment in the third case was not successful because of excessive tension on the flaps. It should be pointed out that in 8 of the 29 cases of chronic fistula there were foreign bodies in the antrum (table 2), only 3 of which could be visualized on roentgenologic examina-



Fig 2—Dentigerous cyst and oroantral fistula. The cyst contained a large fragment of tooth and much fetid pus. The antrum itself, however, was lined with normal mucous membrane. Both the dentist and the previously consulted rhinologist had been puzzled because pus could not be obtained from the nose when irrigations were done through the fistula or through the natural antral ostium.

tion. In 2 cases sequestrums were free in the antrum, in 1 case, iodoform gauze (fig 1), in 2 cases, tooth fragments (fig 2), and in 1 case each, a ball of cotton, a piece of chewing gum and a shell fragment.

COMMENT

In following many cases of oroantral fistula, one is impressed with the lack of cooperation between the dentist or oral surgeon and the rhinologist. Yet, in reviewing the literature, one reads repeatedly the plea for better teamwork between the two specialties. This lack of

cooperation exists apparently because the dentist mistakenly feels that the fistula was the result of an operative error instead of an unavoidable accident, as is frequently the case. For this reason he is often reticent about asking for consultation. Furthermore, there is a tendency to minimize the involvement of the sinus and to attempt vainly to close the fistula without treating the sinusitis. These facts make for a greater incidence of chronic oroantral fistula.

Attention must be given to the involvement of the sinus, whether acute or chronic, or attempts at closure of the fistula will be futile. Such fistulas are primarily problems of acute or chronic sinusitis and should be seen by the rhinologist.⁹ The actual closure of the fistula usually is of secondary importance to the elimination of the sinus disease.

Escharotics should be abandoned. Their use, as suggested by Weih,¹⁰ who used trichloroacetic acid, and Drury,¹¹ who used "liquor epispasticus" (a 50 per cent acetic acid tincture of cantharides), rarely results in complete closure and produces so much scarring that the employment of flaps or grafts later is usually unsuccessful, yet many patients of this series came to me having been treated with silver nitrate regularly until the area surrounding the fistula consisted of the most avascular scar tissue.

In 1925 Lyons¹² recommended a treatment for acute oroantral fistulas in which the soft tissues were routinely sutured over the fistula and an antral window made. No irrigations were allowed. The present use of penicillin makes an antrotomy rarely necessary provided the patient is seen immediately. The irrigations, followed by instillations and systemic administration of penicillin, clear the acute sinusitis quickly. If lavage is done gently, it is my opinion that it does not disturb the wound. In this I differ from Hill.¹³

MacGougan¹⁴ reported a successful result in a case of acute oroantral fistula treated by plastic closure and several irrigations of the antrum. Maxillary sinusitis had developed a few weeks after extraction of a tooth. MacGougan used a 20 per cent suspension of sulfathiazole powder in glycerin for instillation into the antrum after irrigation.

9 Mundt, G. H., in discussion on Lawson, L. J. Changing Concepts of Therapy of Chronic Sinusitis, *Arch Otolaryng* **46** 120 (July) 1947.

10 Weih, E. P. Closure of Alveolar Fistula by Scar Tissue Formation, *Ann. Otol., Rhin. & Laryng* **39** 533-541, 1930.

11 Drury, D. W. A Procedure for the Cure of Antral Fistulas, *Boston M. & S. J* **191** 1123-1124, 1924.

12 Lyons, H. R. The Treatment of Alveolar Fistula Secondary to the Extraction of Teeth, *Tr. Am. Laryn., Rhin. & Otol. Soc* **35** 81-88, 1929.

13 Hill, F. T. Management of the Alveolar Fistula, *Arch Otolaryng.* **40** 167-170 (Sept.) 1944.

14 MacGougan, M. K. Maxillary Sinusitis of Dental Origin. Two Cases Treated Conservatively, *J. Canad. M. Serv* **2** 579-581, 1945.

Lyons also warned against irrigating through the fistula. He opposed packing the socket, yet both these errors were committed twice by exodontists in cases in this series. Hall and Thomas warned against probing the socket, yet 1 patient in this group described the dentist's pushing the probe around in the antrum at all angles to demonstrate to the patient the size of the sinus (fig 3), without realizing that he was succeeding only in enlarging the fistula.

In the management of chronic oroantral fistula, the question whether a radical maxillary sinusotomy is indicated is frequently debated. My experience leads me to agree with those¹⁵ who advocate this more

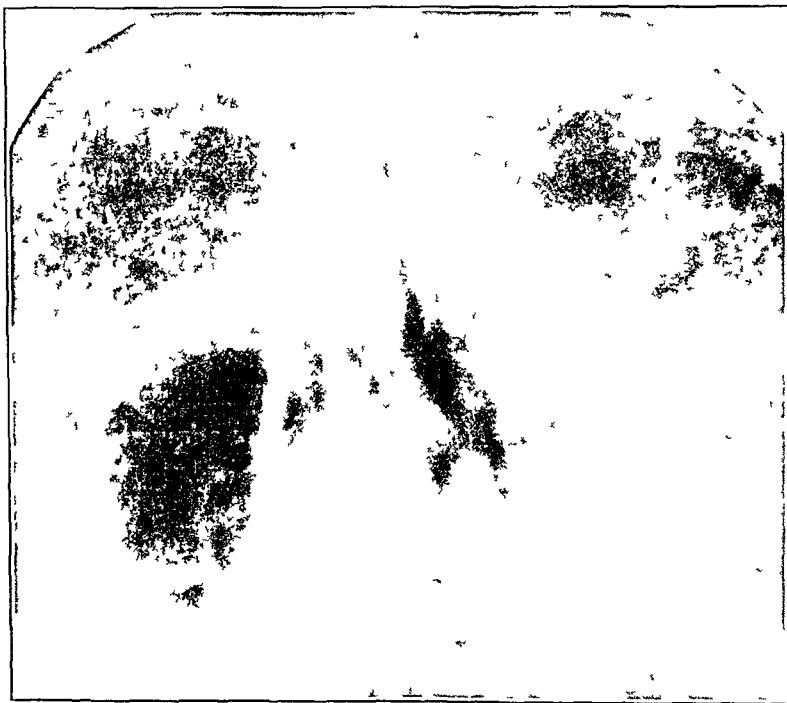


Fig 3—Chronic maxillary sinusitis secondary to an oroantral fistula. The history was a common one, with the dentist wondering whether he had entered the antrum and then probing the socket vigorously to determine whether he had. A primary closure was obtained after a radical maxillary sinusotomy and suturing of the buccopalatal flaps.

radical procedure for uniformly good results. Endonasal operations are occasionally successful, as demonstrated in 1 of the cases in this series, but the radical technic offers a better chance of ridding the antrum of chronic disease. It also offers the surgeon a better opportunity to inspect the sinus for polypoid membrane or a foreign body, as well as

15 Strong⁵ Major⁷ Lyons¹² MacGougan¹⁴ Hempstead, B. E. Intranasal Surgical Treatment of Chronic Maxillary Sinusitis, *Arch Otolaryng* 6:426-433 (Nov.) 1947. Ashley, R. E. A Method of Closing Antral-Alveolar Fistulas, *Ann Otol, Rhin & Laryng* 48:632-642, 1939.

a more complete way of dissecting out the epithelium of the fistulous tract Berger stated that an oroantral fistula should never be closed without careful inspection and exploration of the cavity for a foreign substance As the object may be nonopaque to roentgen rays, only a radical maxillary sinusotomy can provide opportunity for such examination This procedure represents little more of an ordeal to the patient than does an endonasal antrotomy

CONCLUSIONS

1 Oroantral fistula, whether acute or chronic, is essentially a problem of sinusitis and should be managed by a rhinologist

2 Many cases of chronic oroantral fistula or chronic suppurative sinusitis of dental origin could have been prevented had immediate vigorous therapy, such as described here, been instituted

3 Probing, curetting, packing, irrigating or cauterizing an oroantral fistula should be strictly avoided

4 Radical maxillary sinusotomy and Caldwell-Luc operation give the uniformly best results in treatment of chronic oroantral fistulas

5 There is a need of more serious attention by exodontists to oroantral fistulas

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STRUCTURE AND PERFORMANCE IN ANIMAL LANGUAGE

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YOUATT,¹ in 1835, found it hard to explain why his young chimpanzee "had not the slightest power of speech, though he could scream loudly" The fact that higher animals do not make "appropriate" use of their otherwise suitably constructed organ of voice prompted many speculations

The conception that production of sounds and language are related to the degree of development of the brain rather than to the structure of the larynx has found numerous advocates The origin of such statements can be traced to the sentence of Darwin, dating from 1871 "The fact of the higher apes not using their vocal organs no doubt depends on their intelligence not having been sufficiently advanced" This interpretation was extended to conditions as found in man, and so when Polyak, McHugh and Judd,² in 1946, wrote that "It is legitimate to conclude that the cause of relatively late development of the human ability to communicate by spoken words was not the insufficiency of the sound producing and word shaping organs but the poorly developed mental sphere"

The concept of Rochon-Duvigneaud^{2a} with regard to the eye and vision in monkeys is similar namely, that they see with the same eye as man but look and observe with a much inferior brain

Advance in the differentiation of vocal communication may even have branched off from the main phylogenetic line Nissen³ stated that it "may be more highly developed in some infra-primate societies [e g birds] than among the monkeys and apes In chimpanzees, directive communication is largely gestural and postural"

From the Biological Laboratories, and the Department of Otolaryngology, Harvard Medical School This study was aided by a grant from the Ella Sachs Plotz Foundation

1 Youatt, W Account of the Habits and Illness of the Late Chimpanzee, *Lancet* 1835-1836, pp 202-206

2 Polyak, S L, McHugh, G, and Judd, D K The Human Ear in *Anatomical Transparencies*, New York, T H McKenna, Inc, 1946

2a Rochon-Duvigneaud, A *Les yeux et la vision des vertebres*, Paris, Masson & Cie, 1943

3 Nissen, H W Primate Mentality, in Harriman, P L *Encyclopedia of Psychology*, New York, Philosophical Library, Inc, 1946, p 552

Yerkes and Learned⁴ formulated the problem as follows "Although the animals [chimpanzees] have a sound-producing apparatus which presumably is capable of functioning much as does that of man, there is slight, if any, tendency to imitate sound"

In the attempt to coordinate anatomic structure and vocal performance, two surveys have been given earlier (Kelemen⁵) One dealt with an area of special phonetic significance, the junction of the larynx and the resonant tube, the other discussed the role of respiratory voice in comparative phonetics Both studies left the impression that conditions as found in the end organ do not justify one in expecting higher vocal achievement than that commonly observed in untrained animals In a later report,⁶ instead of tracing in a number of different species a single anatomic area or a single phonetic function, it was endeavored, rather, to study anatomy and function in a single species Given a certain structure, the possibility of reaching a degree of phonetic performance warranted by the higher developed mental faculties was reviewed The chimpanzee was chosen because a number of descriptions of its vocal organ are available and because there is no other animal whose vocal performance has been studied and analyzed as thoroughly and competently It seemed advisable to attempt such a coordination because the anatomic descriptions include but few statements regarding function, and analyses of voice and speech of the chimpanzee disregard the anatomic situation The number of animals studied in the pertinent literature is small,^{6b} and such reports as are extant are inadequately supported by histologic evidence and not at all by observations of serial sections Moreover, there is considerable variation in laryngeal musculature in anthropoids

Continuous histologic series of the larynx, divided in midplane into a right and a left half, were examined, with one of the halves sectioned in the horizontal, the other, in the frontal, plane Microscopic observation has shown that the opening of the aditus laryngis directly faces the posterior pharyngeal wall [For detailed description of these series and the grouping according to cartilages, articulations, extrinsic and intrinsic ligaments, muscles and cavity of the larynx, see footnote 6] The larynx is suspended so high that the corniculate and cuneiform cartilages reach the level of the lowest bundles of the lingual muscles

4 Yerkes, R., and Learned, B. *Chimpanzee Intelligence and Its Vocal Expression*, Baltimore, Williams & Wilkins Company, 1925

5 (a) Kelemen, G. *Comparative Anatomical Studies on the Junction of Larynx and Resonant Tube*, *Acta oto-laryng* **26** 276-283, 1938, (b) *Vergleichend-Anatomisches und -Physiologisches zur inspiratorischen Stimmgebung*, *Monatsschr f Ohrenh* **66**:953-963 (Aug) 1932

6 (a) Kelemen, G. *The Anatomical Basis of Phonation in the Chimpanzee*, *J Morphol* **82** 229-256 (March) 1948, (b) *Vergleichende Anatomie und Physiologie der Stimmorgane*, *Arch f Sprach- u Stimmphysiol* **3** 213-237 (Oct) 1939

The full impact of respiratory air current falls on the posterior part of the glottis, while the most frontal section of the vocal cord remains tightly covered by the epiglottis. A posterior channel—hiatus intervocalis, Némai⁷—between the concavity of the cricoid cartilage and the excavated medial surface of the arytenoid cartilages, on the one side, and the vocal process of the arytenoid cartilages on the other, cannot be closed entirely. Covering like a curtain the greater lower part of the entrance to the ventricle, the vocal lip forms a transparent epithelial structure, ending in a sharp upward-turned horizontal edge. The vocal lip is attached by its entire height to the vocal process and the crista arcuata and is moved inward with the displacement of the vocal process, opening the entrance to the ventricle. The conus elasticus is strongest, smoothest and most homogeneous, coming nearest to what can be called a true vocal cord, at the level of the most prominent bulge of the thyroarytenoid muscle, this level corresponds to a level below the floor of the ventricle. An inward curve of the thyroid cartilage lends a solid base for the muscular bulge, resulting in formation of an isthmus at this level. The lateral laryngeal wall is completely pneumatized.

Rather than to add to the volume of speculations of questionable usefulness regarding function, it was preferable to sketch the limitations of phonetic production in comparison with human performance. This procedure seemed to be in accord with the postulate of Revesz,⁸ who pleaded for the omission of spiritualistic hypothesis or complicated theories in psychologic investigations with animals if a simple way would be sufficient to explain occurrence and performance.

With regard to the duration of sounds, difficulty in separating the soft palate from the epiglottis accounts for the absence of long, drawn-out sounds similar to those of human production, since for such sounds a constantly open oral resonant tube is necessary.

The production of double sounds is favored by a "second glottis," placed at a different level, between the arytenoid cartilages. Inter-membranous and intercartilaginous glottides do not act as a unit, as they do in man and in gibbon. The hiatus intervocalis, described by Némai,⁷ is present and makes clear intonation impossible, except in piano, when only the intermembranous glottis is in action.

Inspiratory voice, in man a pathologic symptom, can originate in the chimpanzee at several levels. Except for a very short section near the commissure, the edges of the vocal cords are "indifferently" shaped against a current of air striking from the aditus or from the trachea.

7 Némai, J. Das Stimmorgan der Primaten, *Ztschr f Anat u Entwcklungs-gesch* 81 657-672, 1926

8 Revesz, G. Experimental Study in Abstraction in Monkeys, *J Comp Psychol* 5 293-341 (Aug) 1925

The air sac mechanism is controlled (*a*) by contraction of the platysma and other muscles of the neck spread over the external surface of the sac, (*b*) inside the larynx, by action of a sling formed by muscular bundles branching off from the thyroarytenoid muscle, regulating the patency of the appendix, and (*c*) by a hitherto unobserved action the closing and releasing of the lumen of the appendicular duct by pressure exerted by the muscular mass of the base of the tongue. The air sac mechanism produces sounds independently of the rhythm of respiration.

In relation to the role of the vocal lip, a transparent epithelial structure ending in a sharp upward-turned horizontal edge, sounds produced at this location by the current of air evacuated from the air sacs are neither expiratory nor inspiratory. The role of delicate membranes of birds spread over a certain space was analyzed by Ruppel⁹. Tightly stretched membranes in the bat may tend, according to Griffin,¹⁰ toward the production of supersonic vibrations. Little was observed directly about the movements of the free vocal lip or its phonetic achievement. Some information, however, can be gathered by reports on the hearing, as sound-producing and auditory capacity are closely connected. Elder¹¹ found that the upper limit of hearing for the chimpanzee was superior to that of man, reaching 33,300 cycles per second. At present, a parallel between the production and perception of supersonic frequencies, in connection with the peculiar formation of the vocal lip, can be suggested only as a possibility worthy of future investigation.

To build up the elements of human voice and speech, a far reaching simplification of the end organ has had to be achieved. The emission of double sounds, the use of expiratory and inspiratory phonation, complication by sounds produced at the membranous vocal lip independently from the respiratory rhythm, must have been eliminated in the course of evolution. Their participation in the phonetic performance is not an enrichment, at least in the sense that, with a different mechanism, they make the vocal apparatus utterly unfit to duplicate production of the human voice.

In the opinion of Romer,^{11a} "there is no reason to assume that increasing complexity or addition of new parts are processes which have

⁹ Ruppel, W. Physiologie und Akustik der Vogelstimme, *J. Ornith.* **81** 433-542 (July) 1933.

¹⁰ Griffin, D. L. How Bats Guide Their Flight by Supersonic Echoes, *Am. J. Physics* **12** 342-345 (Dec.) 1944.

¹¹ Elder, J. H. The Upper Limits of Hearing in Chimpanzee, *Am. J. Physiol.* **112** 109-115 (May) 1935.

^{11a} Romer, A. S. Time Series and Trends in Animal Evolution, in Jepsen, G. L., and others. *Genetics, Paleontology and Evolution*, Princeton, N. J., Princeton University Press, 1949, pp. 103-120.

a copyright on the term evolution, simplification may equally be a change leading to survival, which is the only test of success"

It is not that the larynx of the chimpanzee has remained underdeveloped amid progressiveness of the other anatomic parts, its structure forms a basis for a remarkable vocal performance, "of an almost unbelievable amount and intensity,"¹² though within characteristic limits. On the other hand, in spite of high mental qualities, the chimpanzee is incapable of imitating human speech, since its own voice is composed of entirely different phonetic elements

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12 Nissen, H. W. A Field Study of the Chimpanzee. Observations of Chimpanzee Behavior and Environment in Western French Guinea, Comparative Psychology Monographs, Baltimore, Johns Hopkins Press, 1931, vol. 8, no. 1, serial no. 36

ALLERGY AS A CAUSE OF NUCHAL MYALGIA AND ASSOCIATED HEADACHE

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INTEREST in the allergic cause of various myalgias developed as a result of clinical observations on patients undergoing individual food tests¹ for the diagnosis of specific food sensitivity. Myalgia of the cervical muscles has been repeatedly observed to follow experimental ingestion of foods or exposure to inhalants in specifically sensitized persons. The facts that these muscular symptoms may be reproduced repeatedly and at will in experimental circumstances and that such complaints may be relieved by avoidance of incriminated allergens are the basis of the thesis that such manifestations are of allergic origin.

The allergic response of skeletal musculature may be localized to regional groups of muscles, to a single muscle or, apparently, to a segment of a given muscle. In other instances the process seems to involve multiple groups of muscles, such involvement giving rise to the impression that the reaction is generalized in character.

Of the various localized reactions, involvement of the nuchal muscles is the commonest, although similar responses have been observed less frequently in the calf muscles, the hamstrings, the lower muscles of the back, the pectoral muscles, the intercostals and the rectus abdominis. This presentation will be limited to the subject of chronic nuchal myalgia. Acute myalgia, or myositis of the cervical muscles as the result of food allergy, has recently been described as acute torticollis². The clinical evidence favoring the involvement of other muscle groups will be presented in another communication³.

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1 Rinkel, H J. Food Allergy. II The Technique and Clinical Application of Individual Food Test, *Ann Allergy* **2** 504, 1944. Randolph, T G, and Rawling, F F A. Blood Studies in Allergy. V Variations in Total Leucocytes Following Test Feeding of Foods, An Appraisal of the Individual Food Test, *ibid* **4** 163, 1946.

2 Randolph, T G. Allergy as a Cause of Acute Torticollis, *Proc Central Soc Clin Research* **21** 61, 1948, *J Lab & Clin Med* **33** 1614, 1948.

3 Randolph, T G. Allergic Myalgia, to be published.

In the absence of a satisfactory and experimentally demonstrable cause, myalgia of the posterior cervical muscles has been described by a profusion of terms. One of the first descriptions was by Valleix⁴ in 1841, who referred to spontaneously recurring sieges of painful contractions of muscles of the nuchal area as cervico-occipital neuralgia and mentioned André⁵ and Berard⁶ as his predecessors in recognizing this syndrome. He stated that involvement was commonly unilateral, that tenderness was most pronounced in limited areas at the base of the skull, the anterior edge of the trapezius and the posterior edge of the sternocleidomastoid muscle and slightly below the middle part of the neck, that the pain in these areas was accentuated by motion of the head and sometimes radiated to the shoulder or jumped to the frontal area, and, finally, that the pain was materially relieved by immobility. He mentioned that diet, exposure to cold and menstruation were precipitating factors, although he was unaware of the cause.

Norstrom⁶ published in 1885 a treatise on the treatment of headache by massage, this treatise consisted principally of personal cases, but others were borrowed from Henschen⁷ and Wretling⁷. He attempted to show that many cephalalgias were secondary neuralgias starting from deposits of chronic inflammation of the muscles of the neck, the deposits were most commonly localized to the insertions of the muscles but also occurred in the bodies of these muscles. In subsequent editions⁸ he continued to comment on the frequency of tender nutlike indurations on the edges and in the body of the trapezius muscle and along the sternocleidomastoid muscle, occurring in association with parietal or frontal cephalalgia.

In 1911 Edinger⁹ was impressed with the frequency of this clinical picture, which he referred to as indurative headache, and credited the earlier work of the Swedish investigators Henschen, Norstrom and Helliday for his ability to understand and to treat the condition.

Halle,¹⁰ also in 1911, described the contracted painful muscles of the nuchal area, the contraction occurring in association with heaviness, pressure and pain in the head and, less frequently, with nausea, tinnitus

4 Valleix, F. L. I. *Traité des nevralgies, ou affections douloureuses des nerfs*, Paris, J. B. Bailliere, 1841

5 Cited by Valleix⁴

6 Norstrom, G. *Traitement de la migraine par le massage*, Paris, A. Delahaye & E. Lecrosnier, 1885

7 Cited by Norstrom⁶

8 Norstrom, G. *Cephalalgia and Massage*, New York, G. E. Steckert, 1896, *Chronic Headache and Its Treatment by Massage*, *ibid*, 1903

9 Edinger, L., in Church, A. *Diseases of the Nervous System in Modern Clinical Medicine*, New York, D. Appleton & Co., 1911

10 Halle, M. *Myalgien in der Ohrenheilkunde*, *Monatsschr. f. Ohrenh.* 45: 768, 1911

and scotoma. He noticed also the concomitant occurrence of such constitutional symptoms as morning fatigue, tachycardia, a sense of anxiety or tension and a sense of "feeling mean and generally out of sorts," and he stated that such observations were commonly made on neurasthenic types of persons, who exhibited many complaints.

Two otolaryngologists, Mithoefer¹¹ and Seydell,¹² are to be credited with the most complete recent description of this clinical picture. Mithoefer pointed out that in some cases hypertonicity of the muscles of the neck is not accompanied with headache, in contrast with most cases with the commoner association of head pain. He emphasized also that nodular or muscular headaches were commoner in the morning on arising, a point in keeping with their possible allergic cause, in view of the characteristic morning accentuation of symptoms in masked food allergy, as described by Rinkel¹³ and confirmed by me¹⁴.

Seydell emphasized the marked variability in the type and localization of the head pain, the fact that nodular or spastic myalgia may or may not be accompanied with conscious pain or soreness of the cervical muscles, that most frequently the patient is unaware of any discomfort until his attention is called to it by palpation of these muscles and, finally, that the patient rarely connects his headache with the nuchal symptoms. He stated further that the patient's history usually presented evidence of vasomotor imbalance and that he frequently was found to have some sort of allergy. Seydell did not find, however, that the elimination of foods to which allergic patients are sensitive prevented or cured the condition, although he failed to state what type of diagnostic methods were employed.

The rheumatologists also deal with this condition, there is no doubt that certain cases of muscular rheumatism are identical with the previous descriptions. Comroe¹⁵ listed the trapezius and the sternocleidomastoid muscle as those most frequently involved by the fibrositis process. He pointed out also that fibrositis of the cervical muscles has been alleged to produce severe occipital and vertical headaches, as well as acute torticollis.

In the field of neurology, Riley¹⁶ commented on the distinct variations occurring in the localization of head pain in migraine, that painful

11. Mithoefer, W. Hypertonic Muscles of the Neck as a Cause of Headache, *Ann Otol, Rhin & Laryng* **43** 67, 1934, Hypertonic Muscles of the Neck as a Cause of Headache, *Tr Am Laryng, Rhin & Otol Soc* **40** 285, 1934.

12. Seydell, E. M. Indurative or Myalgic Headache, *Arch Otolaryng* **32** 860 (Nov) 1940.

13. Rinkel, H. J. Food Allergy. I. The Role of Food Allergy in Internal Medicine, *Ann Allergy* **2** 115, 1944.

14. Randolph, T. G. Food Allergy, *M Clin North America* **32** 245, 1948.

15. Comroe, B. I. Arthritis and Allied Conditions, ed 3, Philadelphia, Lea & Febiger, 1944.

16. Riley, H. A. Migraine, *Bull Neurol Inst New York* **2** 429, 1932.

symptoms often involved the neck and shoulders and that irritative motor symptoms may present themselves as localized twitchings and fascicular and myoclonic contractions

Other cases with these descriptive features may have been confused with certain orthopedic lesions in instances in which the evidence of structural abnormality may have been somewhat speculative. Such syndromes as cervical arthritis and periarthritis, indefinite anatomic changes in the cervical vertebrae, localized myofascial lesions, anterior scalenus syndrome, cervical rib phenomena, tenosynovitis and bursitis not associated with deposits of calcium may be mentioned in this respect.

It should be apparent that the symptoms described here have been referred to by those interested in psychosomatic disease as "tension headache," the implication being that tenseness causes the neck to be tight and results in a headache. Although it is agreed that tension is frequently a part of this clinical picture, it is to be regarded as a consequence rather than an etiologic factor. It should be pointed out that tension and "nervousness" are integral parts of the fatigue picture of allergic origin, as originally described by Rowe¹⁷ and recently reviewed by me¹⁸.

Muscular aching, insomnia, depression and melancholia are integral parts of this allergic fatigue syndrome. In this connection, it is of significance that Burnett¹⁹ in 1891 carefully differentiated melancholia from neurasthenia, or "nervous exhaustion", stating that the conditions were entirely unrelated. He asserted that insomnia and nuchalgia preceded the development of melancholia and that in the well advanced case the symptoms of insomnia, nuchalgia and melancholia constituted a diagnostic triad, which served to characterize typical cases of melancholia.

Rowe²⁰ in 1931 was apparently the first to regard the presence of pain in the posterior part of the neck and back as an allergic response, demonstrable after the ingestion of specific foods and relieved by avoidance of incriminated foods. He described both localized and generalized

17 (a) Rowe, A. H. Food Allergy Its Manifestations, Diagnosis and Treatment, *J. A. M. A.* **91** 1623 (Nov 24, 1928), (b) Gastro-Intestinal Food Allergy A Study Based on One Hundred and Ninety-Nine Cases, *J. Allergy* **1** 172, 1930, (c) Allergic Toxemia and Migraine Due to Food Allergy, *California & West Med* **33** 785, 1930.

18 Randolph, T. G. Fatigue and Weakness of Allergic Origin (Allergic Toxemia) to Be Differentiated from "Nervous Fatigue" or Neurasthenia, *Ann. Allergy* **3** 418, 1946, Allergy as a Causative Factor of Fatigue, Irritability and Behavior Problems of Children, *J. Pediat.* **31** 560, 1947, The Fatigue Syndrome of Allergic Origin, *Mississippi Valley M. J.* **70** 105, 1948.

19 Burnett, S. G. The Diagnosis of Incipient Melancholia, *New York M. J.* **53** 497, 1891.

20 Rowe, A. H. Food Allergy Its Manifestations, Diagnosis and Treatment, with a General Discussion of Bronchial Asthma, Philadelphia, Lea & Febiger, 1931.

muscle aching as a prominent part of the syndrome which he termed allergic toxemia^{17c} Rinkel²¹ in 1933 mentioned aching of the neck as a point in the prodromal state of migraine due to food allergy Otherwise, the relation of myalgia to other muscular symptoms as a possible manifestation of food allergy has received little emphasis The point of view presented here was reported by me in 1947,²² and Meyer,²³ citing an illustrative case, recently reported that peculiar myalgias and arthralgias that fail to meet any category are often considered on the basis of a food allergy response

Pulling, drawing, tightness and aching of the cervical muscles are some of the most usually encountered symptoms observed in the course of performing individual food tests for the specific diagnosis of food allergy Technicians are trained to observe whether the patient stretches his neck as if his collar were too tight, as telltale evidence of the onset of such nuchal symptoms (Rinkel²⁴ referred to this gesture as the horse collar reaction¹) Simultaneously with extension and flexion of the neck and rotation of the head on the shoulders, patients generally start to massage the nap of the neck Such nuchal symptoms are usually associated with tenderness of the involved muscles, they may or may not develop into headache It is important to point out to those patients who do get head pain after food tests that their headaches may be of any descriptive type, including occasional headaches meeting Horton's²⁵ description of "histaminic cephalalgia"

Once our attention had been called to the fact that this clinical picture was a result of food allergy, my associates and I began to watch for the presence of such symptoms in cases of inhalant sensitivity Although these symptoms are less commonly associated with inhalant allergy, we have observed identical symptoms to result from sensitivity to house dust The syndrome of cervical myalgia has been shown to follow massive exposure to house dust on repeated occasions, in a few instances it has been observed as a part of the constitutional reaction following overdosage of house dust extract Cervical myalgia in such patients has been relieved repeatedly and for characteristic periods of time after the administration of a correctly measured therapeutic dose of house dust extract Furthermore, it has been noted that such symptoms recur after the termination of the period of effective-

21 Rinkel, H J Some Considerations of Allergy as a Factor in Familial Recurrent Headaches, *J Allergy* 4 303, 1933

22 Randolph, T G Muscular Symptoms of Allergic Origin, *Proc Am Federation Clin Research* 4 19, 1948

23 Meyer, M G Nonreagenic Allergy, *Ann Allergy* 6 417, 1948

24 Rinkel, H J Personal communication to the author

25 Horton, B T, McLean, A R and Craig, W M A New Syndrome of Vascular Headache Results of Treatment with Histamine, Preliminary Report, *Proc. Staff, Meet, Mayo Clin* 14 257, 1939

ness of a given therapeutic dose of house dust, these recurrent symptoms have been repeatedly relieved after each subsequent correctly measured therapeutic injection. The diagnostic technics with respect to measuring the degree of dust sensitivity and the therapeutic dosage effective in relieving these symptoms were those described by Rinkel²⁶

For a period, all patients with a history of headache or various types of myalgia were subjected to a careful examination by palpation of the posterior cervical muscles at the time of their initial visits, prior to and after individual food tests and during other periods when they were free from such symptoms. Marked variations in the tonicity and tenderness of the posterior cervical muscles, particularly the trapezius, were noted. In general, there was a distinct tendency for these muscles to be hypertonic and tender to palpation when first seen, at a time when most patients were having chronic undiagnosed allergic symptoms, or after the experimental induction of acute allergic reactions, as against a distinctly lessened tonicity of these muscles and the relative absence of tenderness on palpation when allergic processes were under control. In some instances apparently normal nuchal muscles, as determined by palpation immediately prior to individual food tests, became taut and tender after the ingestion of an allergenic food which had been associated with the development of head pain. In the majority of instances the evidence of contracture, firmness, tautness and tenderness of the involved muscles was the only sign of abnormality. The delayed development of tender nodules in the involved muscles was determined in a few instances.

In some patients the complaint referable to the neck muscles was subjective only and could not be verified by palpation. Other patients denied the presence of such muscular symptoms referable to the neck, yet the typical findings were present on both inspection and palpation. In these instances it was interpreted that the patient had become so accustomed to such symptoms that they had ceased to regard them as anything abnormal.

Seydell emphasized the fact that patients usually do not complain of symptoms referable to the neck muscles, apparently regarding them as a trouble they must continue to endure. Not infrequently, patients told of their experience of reporting such symptoms to their physicians, but when they were not taken seriously, sympathetically or comprehendingly, they did not discuss this aspect of their symptoms at future visits with physicians. Many patients found that physicians usually do not have a workable approach to this type of difficulty, and, although they continued

26 Rinkel, H. J., in round table discussion on Inhalant Allergy, Southwest Allergy Forum, Houston, Texas, 1946, Whealing Response of the Skin, Clinical Application of the Whealing Response, Co-Seasonal Method of Treating Hay Fever, read before annual meeting of the American College of Allergists, April 15, 1949.

to consult with their physicians about more important medical matters, they obtained more relief from current symptoms at the hands of practitioners who treat them with massage. Exceptions to this situation are the acute cases in which tenderness and stiffness are present to such a degree that vigorous massage cannot be tolerated. Apparently, in consequence of their own experience, or perhaps from a common knowledge bearing on this point, many patients with this type of difficulty receive medical attention from both licensed physicians and healers practicing beyond the pale of organized medicine, the patients voluntarily dividing their complaints, depending on whose office they happen to be visiting.

The following clinical examples illustrate the relation of posterior cervical myalgia to headache, as an expression of the allergic reaction.

REPORT OF CASES

R. R., a woman aged 43, had been subject to perennial nasal allergy since childhood, this allergy had been most troublesome during winter months, and individual attacks of sneezing and rhinorrhea had been known to follow exposure to dust. Intermittent abdominal cramps and diarrhea had also been present since childhood, in more recent years, gastrointestinal attacks had followed the ingestion of milk, crab, lobster and shrimp.

For the past seventeen years, the patient had complained of attacks of pulling, drawing and tightness of the posterior cervical muscles. These symptoms sometimes occurred without associated headaches, but more frequently, generalized headaches were preceded by tautness and stiffness of the nuchal muscles. During the winter before her initial visit, stiffness of the neck and shoulders had been present continuously, being particularly troublesome on arising in the morning. Pain in the shoulder and neck usually radiated upward to the cranial attachments of the cervical muscles, but at times also radiated into the shoulder areas. She had also been subject to intermittent bouts of urticaria and a chronic degree of fatigue for the past decade. The fatigue was accentuated during winter months and had been materially relieved while she lived in the South.

The patient had been in good health otherwise except for occasional attacks of sacroiliac pain, the first attack coming on after she strained in opening a window.

On allergic investigation, it was found that she was sensitive to dust, but there was no other evidence of inhalant sensitization. Treatment with house dust during the past winter has been effective in completely relieving the symptoms referable to the neck and associated headaches. She obtains approximately ten days of relief from the muscular symptoms and headaches after each dust treatment and notices the recurrence of fatigue and cervical myalgia from between ten and twelve days after each dust injection. A longer interval between injections is followed by recurrence of the headaches.

By avoiding milk and incriminated sea foods, she has not had any recurrence of gastrointestinal symptoms. The inadvertent or experimental ingestion of these foods has been followed by sharp gastrointestinal reactions. The avoidance of eggs and chocolate has controlled the urticaria. The ingestion of either has been shown to precipitate urticaria or pronounced edematous reactions of the orbital structures.

D S, a housewife aged 32, had had recurrent headaches since the age of 16. The onset of individual attacks was characterized by an initial sense of tenseness at the nape of the neck, followed by progressive drawing and tautness of the posterior cervical muscles. Aching pain at the base of the skull gradually extended over the head to the frontal area bilaterally. In some attacks the muscle tightness spread over the shoulders and the upper part of the back. The headaches were occasionally associated with dizziness and nausea, but there were no other gastrointestinal or neurologic manifestations. At times, particularly in recent years, she has had continuous headaches for periods of several days or weeks, during which she complained of constant aching and stiffness of the nuchal muscles, as well as of tenseness and drawing of the muscles of the lower part of the back, although repeated roentgenograms of the spine did not reveal any structural abnormality to account for these symptoms. Some transitory relief from the muscular symptoms was obtained by massage.

The patient has also been subject to chronic fatigue, which at first was present intermittently, but which has been a constant symptom during the past three years. The fatigue was characteristically accentuated in the mornings, present to a greater extent on certain days than on others, not relieved by an excessive amount of sleep and, at times, interfered materially with her daily work. She had periods of extremely troublesome insomnia. At times she was unable to fall asleep, and at other times she awakened in the middle of the night and was unable to return to sleep. She commonly awakened with a violent nightmare.

Intermittent mild nasal stuffiness had been present for several years but had never been a major symptom. The patient stated that ingestion of members of the cabbage family caused gastrointestinal symptoms, but she suspected no other foods.

A diagnosis of brucellosis (undulant fever) had been entertained on several occasions but had never been established. Treatment with thyroid failed to alter the course of the chronic fatigue or other symptoms. Repeated physical examinations did not reveal any abnormality to explain the numerous symptoms. There was no evidence of inhalant sensitivity either from the history or from skin tests with inhalants.

An individual food test with wheat was followed by a violent migraine type of headache, which began with the customary pulling and tautness of the posterior neck muscles. A similar test with corn was associated with recurrence of myalgia of the shoulders and slight nasal stuffiness. A test with potatoes was followed by intense itching of the ears, mild rhinitis and recurrence of insomnia the night after the test. The experimental feeding of eggs was associated with the development of fatigue, excessive belching and recurrence of the aching type of pain across the shoulders and the posterior portion of the neck. Sensitivity to grapefruit was determined from food diary evidence, in that each meal in which it had been eaten was followed by abdominal cramps.

By avoiding the incriminated foods, the patient has had complete relief from headaches, fatigue, insomnia, nightmares and the muscular symptoms referable to the posterior portion of the neck and the lower part of the back. On repeated occasions, the deliberate or inadvertent ingestion of wheat, potatoes or eggs has resulted in the recurrence of these symptoms.

A G, a dentist aged 48, had been subject to periodic sick headaches since 1928. These attacks had been occurring with increasing frequency for the past eight years, and immediately prior to his initial visit in the spring of 1947, he had been awakening with a low grade headache.

Individual seizures of migraine usually began with a drawing sensation, tautness and aching pain in the left posterior cervical muscles, which, in the course of three or four hours, would be followed by severe occipital or frontal pain on the left. Less frequently, the head pain started in the frontal or occipital areas and subsequently involved the nuchal muscles. During the severer bouts, he usually had associated photophobia, blurring of vision, scotomas, hoarseness and thickness of speech, and he complained of exhaustion, impairment of memory and inability to concentrate.

Not infrequently, he would awaken with soreness and tenseness of the trapezius muscles and the muscles in the small of the back. Approximately twice yearly on the average, he was awakened during the night or in the morning with acute wryneck, this was characterized by exquisite pain and tenderness sharply localized to the superior fibers of the belly of the trapezius muscle, pronounced spasm of the affected muscle and such extreme pain on motion of the head as to immobilize the head and shoulders.

Unrelated to the headaches were intermittent, sharp transitory chest pains, these occurred most commonly in the left side of the chest and seemed to be localized to the superficial musculature of the chest. These pains did not radiate in any characteristic manner and were unaffected by respiratory movements.

In addition, the patient had been subject to perennial nasal allergy for several years, this was characterized by morning accentuation of nasal obstruction, an increase of postnasal mucus and a hacking type of cough. He also had intermittent bouts of sneezing at any time of the day. Any type of alcoholic beverage precipitated a headache, and at times the patient suspected also milk, orange and peanuts of bringing on an attack of head pain.

Repeated physical examinations and electrocardiograms did not indicate any significant abnormality. There was no evidence of inhalant allergy, and cutaneous and intracutaneous tests with inhalants gave negative results. An individual food test with milk was associated with the development of somnolence ten minutes after the initial experimental feeding. A second feeding of milk was followed within a few minutes by extreme fatigue and an unmistakable accentuation of the rhinitis. The patient had a severe headache on awakening the following morning. A similar test with corn produced decided weakness and "trembling" sensations, beginning one-half hour after the second feeding, these were followed in an hour by a headache of such severity as to require ergotamine for symptomatic relief. An individual food test with eggs was associated with pronounced leukopenia in the absence of reactive symptoms. Similar tests with wheat and potatoes did not produce any symptoms.

On the third day of a diet omitting milk, corn and the suspected foods, orange and peanuts, he noticed a striking relief from the headaches and related muscular symptoms. Sensitivity to rice was suspected on the basis of food diary evidence and confirmed by an individual food test. With the elimination of these incriminated foods, the patient reported that he was able to accomplish twice as much work, was much less irritable and was able to think better.

During the past year he has found that grapefruit produced these symptoms, and he now finds that eggs and pork are not tolerated in successive feedings but may usually be rotated in the diet. On different occasions, the ingestion of small amounts of corn sugar has resulted in the precipitation of headaches. By avoiding the major offending foods and by spaced feedings of several other foods to which he is less sensitive, he had remained free from troublesome headaches and myalgia. In view of the widespread nature of food reactions, it has not been possible to afford him complete relief from symptoms, but he estimates that he has improved approximately 80 per cent.

H H, a social worker aged 59, had had intermittent headaches for fifteen years. Individual attacks usually began with sensations of tightness and drawing of the posterior cervical muscles and were followed by the development of generalized head pain, usually associated with scotomas and nausea. In recent years she experienced a persistent tightness and stiffness of the posterior cervical muscles occurring between the episodes of head pain. These symptoms had been so troublesome that she sought the regular services of a masseur.

For a year prior to her initial visit in the spring of 1947, she had had persistent rhinitis with superimposed attacks of acute nasal obstruction, each attack lasting two or three days. Chronic fatigue, unrelieved by a customary, or even an excessive, amount of rest, had also been present for the same period. In addition, the patient complained of occasional unexplained attacks of abdominal cramps, associated with loose stools containing copious amounts of mucus. She knew that exposure to house dust accentuated the nasal symptoms but did not suspect items of diet to be the precipitating factors.

Except for typical morphologic changes in the nasal mucous membranes, and tenderness, increased tonicity and "doughiness" on palpation of the posterior cervical muscles, the physical examination showed no abnormalities. On allergic investigation, it was found that the patient reacted positively to house dust but reacted negatively to other inhalant allergens.

An individual food test with corn was associated with the development of somnolence and rhinitis thirty minutes after the initial feeding, followed shortly by the coincident development of a severe generalized headache and a sense of increased pulling and drawing of the posterior cervical muscles. These symptoms persisted for twenty-four hours after the test, as contrasted with the absence of such symptoms prior to the test feeding, except for the usual degree of chronic cervical myalgia. The headache and symptoms referable to the neck were so troublesome after the corn test that the following day she consulted her masseur, who reported that the posterior cervical muscles and muscles of the back were strikingly tighter and more spastic than on numerous previous examinations.

The milk test produced a sense of chilliness which began five minutes after the experimental ingestion of the milk and which was followed four hours later by colicky cramps and diarrheic stool. Similar tests with wheat and potatoes were not followed by an accentuation of symptoms.

The initial diagnostic diet eliminated corn, milk and other foods of high dietary incidence which had not been subjected to individual testing. On the third day of this diet, the patient reported considerable improvement in the degree of chronic fatigue and muscle stiffness. The untested foods were then returned to this diet and tolerated, with the exception that the cumulative ingestion of both orange and eggs was followed by recurrence of myalgia and headache.

With the avoidance of corn and milk, the use of all other foods on a rotating, diversified schedule and the continuation of specific dust therapy, she reported a pronounced improvement generally. The fatigue and rhinitis were no longer present, there were no troublesome headaches, and the myalgia was greatly improved. Her masseur reported that the posterior cervical and lumbar muscles were much less tight and "gummy." The patient observed that she was able to move her head through a greater range of motion than previously and was free from the chronic stiffness that had formerly characterized the posterior cervical musculature.

On repeated occasions the ingestion of small amounts of milk or corn, particularly in the form of corn sugar, was effective in reproducing the former symptoms. Her only severe headaches were invariably related to breaks in her diet, particularly with respect to the inadvertent ingestion of corn products.

G H, a physician aged 44, had been subject to infantile eczema between the ages of 1 and 12 years, chronic perennial nasal allergy since early childhood, seasonal ragweed hay fever of three years' duration, intermittent episodes of perennial asthma since 1933, which were accentuated during the hay fever season in recent years, and, finally, bouts of hemicrania, associated with cervical myalgia of five years' duration, attacks of which had occurred with increasing frequency and severity during the past two years

The individual attacks of head and neck pain were characterized by the gradual onset of mild head pain on the right frontal area, which gradually increased in severity and spread over the entire lower right side of the head becoming, at the end of three or four hours, most intense at the points of cranial attachment of the right posterior cervical muscles. At this stage the pain was intense and pulsating and was exaggerated by changes in posture, particularly on bending forward or on attempting to arise from the sitting to the erect position

Individual attacks developed at any time of the day, they persisted from one to three days each and were not associated with any visual, neurologic or gastrointestinal symptoms. Pressure over the nuchal attachments on the right was effective in relieving these attacks only while the pressure was maintained. Although these episodes were not incapacitating, the patient was more irritable during the attacks and found it more difficult to carry on with his daily routine than when free from them

For a number of years he had been prone to pyrosis, excessive gas, flatus and bloating. In addition, he had been subject to fascicular contractions, involving the deltoid, pectoral and orbital muscle groups and occurring without associated headache or other allergic symptoms, but gradually increasing in frequency during the past five years. He stated that during this time, on attempting to arise from a sitting position, he experienced tautness and stiffness of the hamstring and calf muscles of both legs, which were relieved after ten or twelve steps. At one time, for three months, he experienced tenderness of the right achilles tendon, present only on extension of the foot, with the consequent stretching of this tendon. At another time, for several months, he had an acute pain in the right shoulder on attempts to extend the arm above the shoulder

For the past twenty years, the patient had been subject to chronic tiredness, worse on certain days than on others, but unrelated to the amount of sleep or rest obtained. This fatigue had been associated with difficulty in concentrating, which materially interfered with his ability to read comprehendingly. Although these symptoms were present to some extent at all times, they were commonly accentuated for two or three hours after the noon meal and on arising in the morning. For several years he had been regarded by his associates as unfriendly and reserved and had had unexplained periods of mild depression and melancholia

At no time on examination was tenderness elicited or were nodules observed at the points of cranial attachment of the cervical muscles, and no other physical abnormalities could be detected. The clinical evidence of sensitivity to dust, feathers and silk was confirmed by positive reactions to skin tests with these materials. There were also positive reactions to skin tests with other inhalants, namely, ragweed pollen and orris root, although there was no current evidence of specific intolerance to these agents

Avoidance of and specific therapy with house dust, feathers and silk aided in relieving the respiratory symptoms, but did not bring about a satisfactory degree of relief and did not alter the course of the other allergic symptoms

Diagnostic studies were then undertaken for the detection of food sensitivity. Fifteen minutes after an individual food test with wheat, the patient complained

of excessive gas and bloating, these were followed by a sensation of light-headedness, giddiness and mental confusion. One-half hour after the second feeding of wheat, nasal congestion, sneezing and coughing occurred and persisted for the following twenty-four hours. He reacted compatibly to the experimental ingestion of many other major foods.

With the maintenance of inhalant therapy and the complete avoidance of wheat, there have been no unexplained recurrences of the rhinitis, asthma, gastrointestinal symptoms and localized or generalized muscular symptoms. The experimental or inadvertent ingestion of wheat reproduced the respiratory symptoms on several occasions. The symptoms of the fatigue syndrome have been completely relieved, and the patient has had only one unexplained mild headache. There has been a tremendous improvement in his sense of well-being, sociability and general outlook on life.

COMMENT

In view of the incidence with which the complaint of stiffness and aching of the posterior cervical muscles is encountered in allergic persons, both with and without associated head pain, and the frequency with which this disorder may be induced in the practice of allergy during diagnostic experimental food tests, it is surprising that it has not received greater emphasis as an allergic manifestation. Although first described in this connection by Rowe^{17a} approximately twenty years ago, the allergic interpretation has actually received but meager confirmation. Instead, these symptoms seem to be considered most frequently as a so-called psychosomatic expression or as a manifestation of the rheumatic state under the descriptive term of "fibrositis."

Pulling, drawing and tautness of the posterior cervical muscles have long been regarded as a functional disturbance, and when they occur in association with head pain, the clinical picture is most commonly referred to as "tension headache", this term carries the implication that the tense nuchal muscles are the cause of the associated headache. Although it is true that these symptoms usually occur in a sequential order, as superficially to suggest such a cause and effect relationship, the fact remains that in many persons identical muscular symptoms and headache begin simultaneously, or the onset of the cephalalgia actually precedes the onset of the myalgia. These commonly occurring types were illustrated in the case reports. Furthermore, individual cases have been observed in which on one occasion the myalgia might precede the cephalalgia, and on another the myalgia might follow the head pain, and at other times either the nuchal symptoms or the symptoms referable to the head might be the sole manifestation of an intermittent attack. In view of these common observations and the fact that I have never been able to reproduce experimentally the clinical features of nuchal myalgia in patients with such symptoms but who previously had been given the diagnosis of an allergic condition and treated for it and subsequently exposed intentionally or inadvertently to tension-producing or emotional experiences of the

type alleged to act in a causative manner, I am convinced that there must be some other underlying cause of both the myalgia and the headache

It should be emphasized that the term fibrositis is a descriptive designation, carrying little meaning so far as etiologic factors are concerned. Even attempts to find an explanation of the pathogenesis of fibrositis, from the standpoint of careful examination of the cervical muscles involved in the fibrositis process, have met with variable results.²⁷

Designations of "tension headaches," typical migraine or "fibrositis" of the neck muscles are examples of the profuse confusion and speculation with respect to the clinical evaluation of localized pain and aching sensations affecting the lower portion of the occiput, the neck, upper part of the back and the shoulders

Attempts to differentiate such descriptive entities are rendered even more difficult, in view of the fact that one patient not uncommonly has several kinds of myalgia and cephalalgia. Actually, little is gained by such pedantics, so far as helping the patient is concerned, the use of such terms generally results in a process of pigeonholing and forgetting on the part of the physician and the seeking of other advice on the part of the patient

Inasmuch as medical terminology is moving away from descriptive diagnosis of this type and toward diagnoses which carry an etiologic connotation, it appears advisable to discard such poorly defined designations in favor of an etiologic nomenclature whenever it can be established

No claim is made that all symptoms of the type described here are of allergic origin, and not every condition with such associated symptoms can be specifically diagnosed and relieved as a result of allergic management. The fact remains that these symptoms may be experimentally and repeatedly reproduced in certain persons by an overdose of house dust therapy, in specifically sensitized persons by massive exposure to house dust and in food-sensitive persons by the intentional or accidental ingestion of specific food. It would seem preferable to designate cases in which this cause and effect relation may be repeatedly demonstrated as instances of allergic myalgia or allergic headache associated with nuchal myalgia, and other cases as headache or cervical myalgia of undetermined cause, until a satisfactory relation between cause and effect may be experimentally demonstrated

²⁷ Stockman, R. Rheumatism and Arthritis, Edinburgh, W. Green & Son, 1920. Collins, D. H. Fibrositis and Infection, *Ann Rheumat Dis* 2:114, 1940. Clawson, B. J., Noble, J. F., and Lufkin, N. H. Nodular Inflammatory and Degenerative Lesions of Muscles from Four Hundred and Fifty Autopsies, *Arch Path* 43:579 (June) 1947. Steiner, G., Freund, H. A., Leichtentritt, B., and Maun, M. E. Lesions of Skeletal Muscles in Rheumatoid Arthritis, *Am J Path* 22:103, 1946.

SUMMARY

Myalgia of the posterior cervical muscles has been considered in the past under a profusion of descriptive terms, in the absence of any clear conception of an underlying cause

The clinical syndrome characterized by pulling, drawing, aching, tautness, stiffness and decreased mobility of the nuchal muscles, with and without associated head pain, has been observed, in the absence of any structural abnormalities, as an allergic manifestation, confirming the early observations of Rowe. Specific inhalants (house dust) and foods have been incriminated as causative agents, as evidenced by their ability to reproduce the syndrome in certain patients, either by exposure to house dust or by an overdose of house dust extract in specifically sensitized patients, or as a result of the test ingestion of inadvertent ingestion of foods in food-sensitive patients. Avoidance of dust by and specific therapy of the dust-sensitive patient and avoidance of known food allergens by the food-sensitive patient have resulted in relief from symptoms of this type.

Involvement of the neck muscles is the most frequently encountered manifestation of allergy affecting the skeletal musculature, although the process may localize in various other muscles or give rise to more generalized muscular symptoms.

In the cases studied, no support could be demonstrated for the theory that such clinical symptoms are manifestations of "nervousness" or psychosomatic disturbances. The term "tension headache" is believed to be a misnomer, so far as it carries any etiologic connotation.

PROBLEM OF SO-CALLED CONGENITAL ATRESIA OF THE EAR

Histologic Report of a New Case

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NEW YORK

THE TERM "congenital atresia" is used to designate a group of relatively frequent unilateral or bilateral malformations of the external and middle ear and, in some instances, also of the inner ear. These malformations are more or less independent of one another in their manner of development but may be combined and coordinated in different ways. Atresia of the external meatus, the malformation from which the whole complex derives its name, is present in the majority of cases but not always so. In some instances the meatus is only partially missing or hypoplastic, and in very rare instances entirely normal. It seems startling at first that such cases should also be contained in this group, but it becomes understandable if one realizes that originally the atresia was believed to represent a well defined malformation. Later, however, it became clear that the atresia is only one of a whole group of malformations affecting the derivatives of the posterior ends of the first and second branchial arches. It was then realized that there is no essential genetic difference between cases with and without atresia. As a matter of expediency, the familiar and already accepted term "congenital atresia" was applied to the whole complex.

In spite of the relative frequency of these malformations and their considerable practical importance, only a limited number of cases have so far been examined anatomically or histologically. In many of them the examination was not complete enough or the report not sufficiently clear to permit a genetic analysis. A thorough knowledge of the complicated development and the intricate structure of the ear is an essential prerequisite for the study and proper description of these cases. This might explain the unsatisfactory character of many of the available reports.

In these circumstances every new case which is thoroughly described and analyzed is a valuable contribution to our still incomplete knowledge of this subject.

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REPORT OF A CASE

A girl, born at approximately the normal termination of an undisturbed pregnancy, died after two days (Dec 30, 1946) Nothing is known about malformations in the family

The postmortem examination disclosed multiple malformations (heart with transposition of the great vessels, right-sided hydroureter and hydronephrosis, cystic fibrosis of the pancreas and others)

The head showed normal configuration The right auricle was normal, the left auricle occupied its normal position but was slightly smaller and was malformed The helix was poorly developed, the anthelix prominent and the tragus rudimentary, immediately in front of it, there was a small appendage The external auditory meatus was completely absent There was bilateral cleft palate, extending anteriorly to within 7 mm of the anterior margin of the premaxilla The upper lip showed normal configuration Otherwise the throat and nasopharynx appeared normal Both tubal openings were at the normal place Cross sections through the cartilaginous tubes showed the cartilage present on both sides and the lumen of normal width

Histologic Examination of the Temporal Bones—Left Temporal Bone (vertical serial sections) External Ear The folds and hillocks which composed the malformed auricle consisted of connective and fat tissue The auricular cartilage was rudimentary and situated in the deeper parts, showing a complicated configuration with numerous excrescences on which bundles of striated muscles were inserted It did not extend into the folds and hillocks

The external auditory meatus was absent, and its place was taken by connective and fat tissue

The parotid gland was not found in its usual place

Middle Ear The osseous part of the eustachian tube had a narrow lumen but normal structure

The tympanic cavity had a greatest length of 11 mm, height of 10 mm and width of 5 mm The lumen was very well developed considering the age, measuring 10 by 8 by 4 mm The window niches were already free, the epytympanic space and some niches in the walls were still filled with myxomatous tissue The antrum contained myxomatous tissue into which a small recessus of the lumen of the middle ear extended

Anteriorly, the lower part of the tympanic cavity went over into the eustachian tube, the upper part into a wide anterior recessus (fig 1) which extended for about 3 mm forward Posteriorly, the upper part of the lumen extended into the antrum, the lower part continued along the floor backward beyond the level of the ampulla of the posterior vertical canal (figs 4 to 7)

The lumen of the tube was lined with pseudostratified ciliated columnar epithelium The same epithelium also covered the lower parts of the tympanum throughout almost its entire length The other parts were lined with high cuboidal epithelium The mucosa showed normal structure, there was evidence of a fresh purulent infection with exudate in the lumen

Osseous Walls—In the lateral wall the tympanic bone and the tympanic membrane were missing The resulting defect was partially filled out through a downward extension of the squama which is more marked in the posterior parts than in the other parts (figs 5 and 7) In addition, a bony lamella in the posterior parts extended upward from the lateral part of the floor of the middle ear (figs 3 to 7) Behind the place where the facial nerve left the middle ear, the squama met the lower lamella and fused extensively with it as well as farther

backward, where it fused with the small petrosal portion of the mastoid process. An ovoid-shaped area with an approximate length of 6 mm and height of 5 mm remained, it was filled out with strands of dense connective tissue (fig 4).

It might be mentioned here that the zygomatic process of the squama and the glenoid fossa were well developed. The latter was formed entirely by the squama. The mandibular joint and the mandible showed normal configuration.

The anterior part of the squama was rudimentary, its place was taken by a backward extension of the greater wing of the sphenoid bone which extended

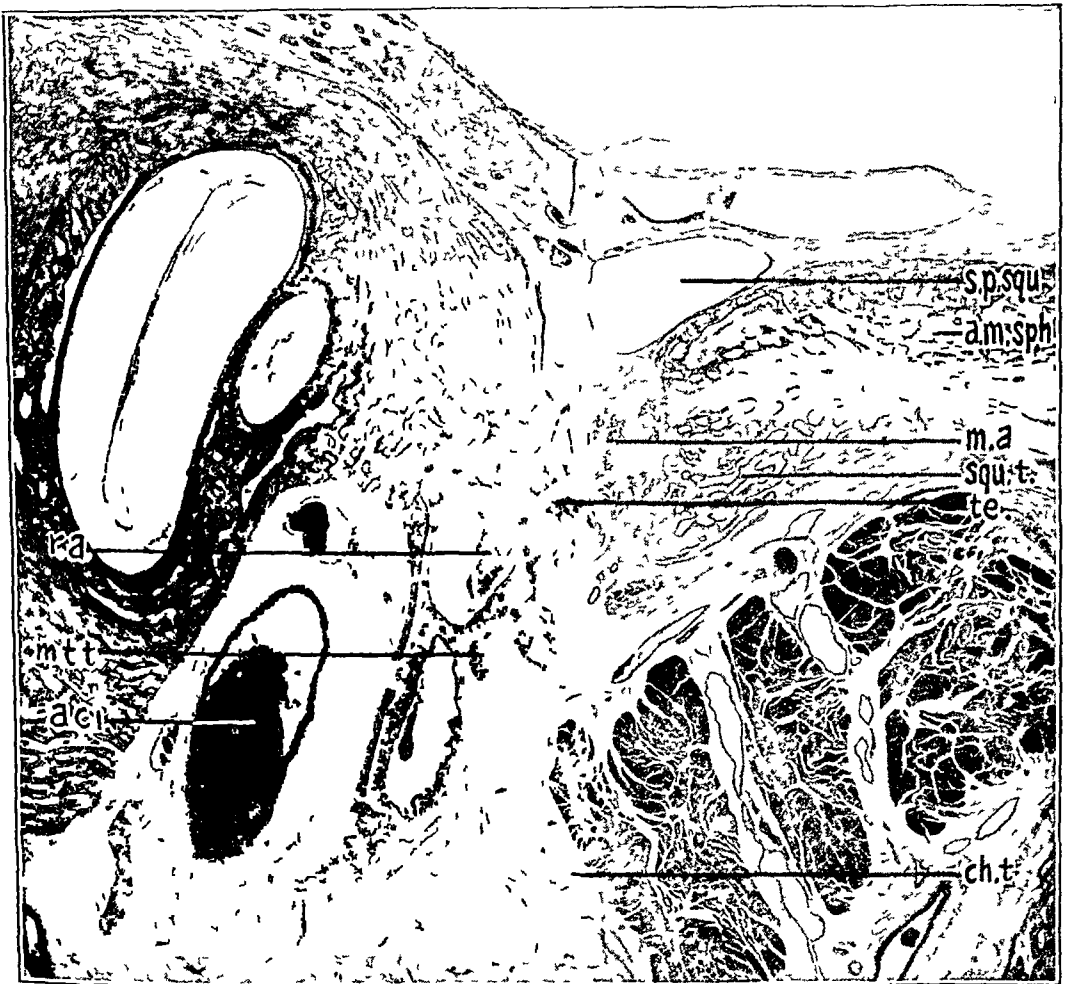


Fig 1—Section through the osseous part of the tube. The abbreviation *a, c* indicates internal carotid artery, *a m sph*, greater wing of the sphenoid, *ch t*, chorda tympani, *m a*, accessory muscle in tegmen, *m t t*, tensor tympani muscle, *r a*, anterior recessus of the middle ear, *s p squ*, petrosquamous sinus, *squ t*, temporal squama, and *te*, tegmen.

backward to the antral region. The upper half of the anterior part of the squama lay on the outer surface of the greater wing and was separated from the latter by a thin layer of dense connective tissue (figs 1 to 7). It was only behind the posterior end of the greater wing of the sphenoid that the squama actually formed a part of the lateral wall of the skull.

The tegmen was somewhat narrower and thicker than normal, at least in the anterior part. It took its origin from a somewhat lower point of the labyrinthine

capsule than normal and extended from its point of origin in a caudolateral direction and terminated laterally with two lips, the upper thicker and the lower thinner (fig 2) Both of these bordered on the medial surface of the squama, the inferior



Fig 2—Section through the anteriormost part of the middle ear The abbreviation *a m sph* indicates greater wing of the sphenoid, *cht*, chorda tympani, *m t t*, tensor tympani muscle in the canal of the lower lip of tegmen, *p st*, styloid process, *s p squ*, petrosquamous sinus, *squ t*, temporal squama, *t m a*, tendon of the accessory muscle, inserting in a groove in the upper lip of the tegmen, and *te*, tegmen

lip was fused with the latter in many places The lower end of the greater wing of the sphenoid bone in the anterior part was a short distance from the lateral

end of the upper lip of the tegmen. In the posterior part, on the other hand, they bordered on each other without, however, fusing at any place. The lower lip of the tegmen terminated in its anterior part in a longer lateral and a shorter medial lamella. In this way a semicanal with an opening directed downward was formed which contained the posterior part of the belly and the tendon of the

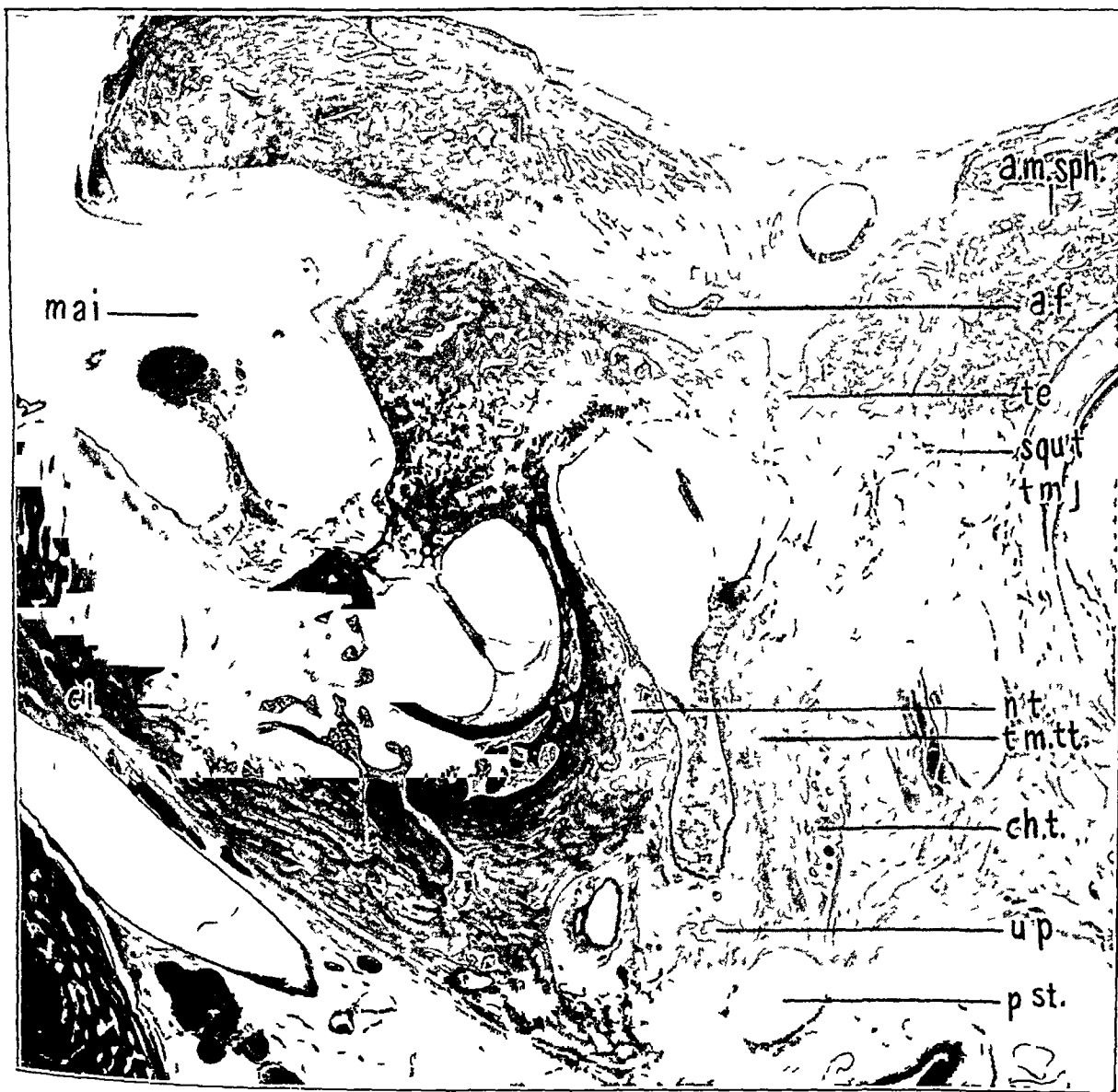


Fig 3—Section through the anterior part of the middle ear. The abbreviation *a f* indicates a branch of the internal auditory artery accompanying the facial nerve, *a m sph*, greater wing of the sphenoid, *c i*, cartilage island in the endochondral labyrinthine capsule, *ch t*, chorda tympani, *m a i*, internal auditory meatus, *n t*, tympanic nerve, *p st*, styloid process, *squ t*, temporal squama, extensively fused with the lower lip of the tegmen, *t m j*, temporomandibular joint, *t m t t*, tendon of the tensor tympani muscle, *te*, tegmen, and *u p*, upward process from the floor of the middle ear.

hypoplastic tensor tympani muscle (fig 2). Between the anterior part of the upper lip of the tegmen and the medial ends of the greater wing of the sphenoid bone

and the squama, there was a deep groove which contained an anomalous muscle embedded in fibrous tissue (fig 1) The latter was about 3 mm long and 0.75 mm thick and consisted of striated muscle fibers It originated with a short tendon from the periosteum of the tegmen and of the greater wing of the sphenoid bone at approximately the level of the foramen ovale Posteriorly its insertion was a somewhat longer tendon in the periosteum of a groove which



Fig 4—Section through the windows The abbreviation *a m sph* indicates greater wing of the sphenoid, *b v j*, bulb of the jugular vein, *ch t*, chorda tympani, *d*, defect in the lateral wall filled with strands of dense connective tissue, *l r*, lower recessus of the tympanic cavity, *n VII*, facial nerve with concomitant artery in the tegmen, *p st*, styloid process going over into the malformed outer ossicle, *r w n*, round window niche, *s p squ*, petrosquamous sinus, *squ t*, temporal squama, *st*, stapes, and *t m t t*, tendon of the tensor tympani muscle inserting at the bony process extending upward from the floor

was formed between the main part of the upper lip of the tegmen and a bony process originating from the latter and extending in a mediolateral direction over the tendon (fig 2) The muscle received its innervation from a branch of the third division of the trigeminal nerve

The floor was formed by a bony lamella of the os petrosum which originates from the labyrinthine capsule It was thicker in the anterior portion and thinner in the posterior part

On the medial wall the promontory and the window niches showed normal configuration The fissura ante fenestram was well developed, of the fossula post fenestram, there were only traces present A few bony bridges extended from the lower part of the promontory across the lumen to the lateral wall

Styloid Process and Ossicles—The styloid process, with the exception of its uppermost part, was still cartilaginous Its lower part showed the usual course It had a diameter of 0.75 mm which toward the upper end increased to about 1.25 mm The upper part of the styloid lay on the lateral surface of the bony lamella which formed the floor of the middle ear At the posteroinferior margin of the defect in the osseous lateral wall, approximately at the level of the subiculum promontorii, it turned from its backward and upward course, upward and slightly forward, traversed the defect in the bony wall, came very near to the inferior margin of the squama, then turned slightly medially and eventually reached into the malformed ossicle (fig 4) At the place where the styloid changed its course, a process which is 1 mm thick continued in the original direction for 1.5 mm and ended a short distance behind and below the place where the facial nerve leaves the middle ear It was surrounded by a thin layer of bone from the lateral part of the floor of the middle ear (fig 5)

The malformed ossicle consisted of a main part or body and two processes The body lay in the epitympanic space, and, while a part of its anteromedial surface was very close to the tegmen, it did not fuse with it The styloid process went over into the anteromedial part of the body One of the two processes extended in a medial direction across the lumen of the middle ear to the medial wall and was here fused with the bony wall of the facial canal (fig 5), while the other process went backward into the antrum and was connected to its lateral wall by dense connective tissue fibers (fig 7) There was no connection between this ossicle and the stapes The ossicle, with the exception of small areas on its surface, was completely ossified At the point of its junction with the styloid process, the ossification could be seen progressing into the upper end of the latter process

The stapes and the annular ligament showed an approximately normal configuration The capitulum was covered with a thin layer of cartilage, with the exception of a small area in its upper circumference, from which a thin and short bony bridge ran to the inferolateral part of the circumference of the osseous facial canal In this way an osseous ankylosis of the stapes was brought about (fig 6)

Muscles—The tensor tympani muscle was noticeably hypoplastic and was displaced laterally In the osseous tube its belly lay near the superolateral circumference of the lumen (fig 1) and farther backward in the semicanal formed by the lateral end of the lower lip of the tegmen (fig 2), which has already been described Its tendon was split into two parts, one of which inserted at the body of the malformed outer ossicle at the place where it was fused with the upper end of the styloid process, the other part inserted at the upper end of a bony process which extended from the floor of the middle ear upward along the medial circumference of the styloid (fig 4) The muscle was, as usual,

innervated by a branch of the third division of the trigeminal nerve. The anomalous muscle in the anterior part of the tegmen, innervated from the same source, has already been described.

The stapedial muscle was well developed and inserted at the usual place.

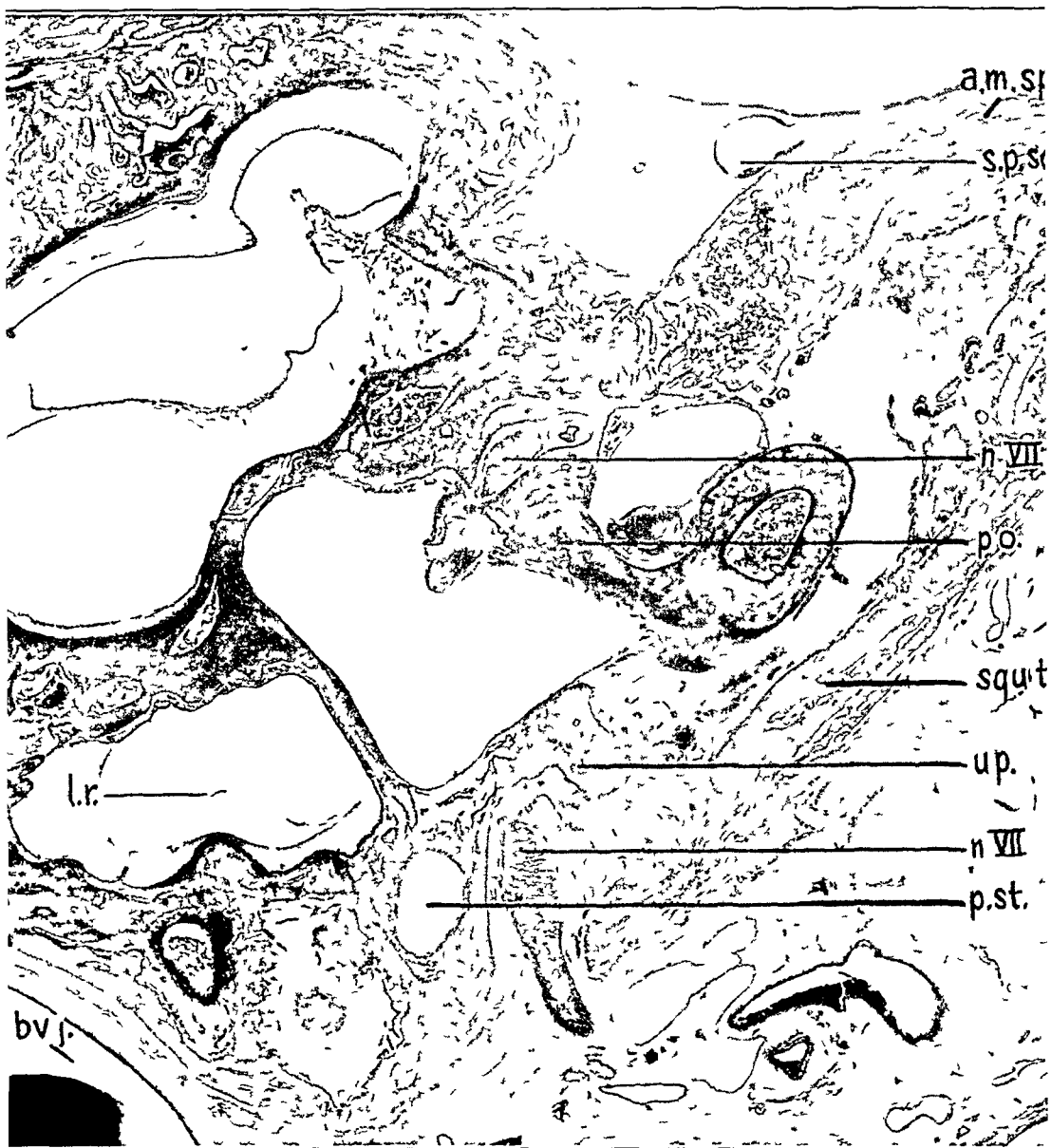


Fig 5—Section through the point of exit of the facial nerve. The abbreviation *a m sph* indicates greater wing of the sphenoid, *b v j*, bulb of the jugular vein, *l r*, lower recessus of the tympanic cavity, *n VII*, facial nerve, *p o*, medial process of the outer ossicle fused with the wall of the facial canal, *p st*, styloid process, *s p squ*, petrosquamous sinus, *squ t*, temporal squama extending far downward, and *u p*, upward process from the floor of the middle ear.

Nerves—The facial nerve showed a normal course within the internal auditory meatus and up to the geniculate ganglion, from the ganglion the greater superficial

petrosal nerve went off forward. The facial nerve itself turned backward and was enclosed in the tegmen for a short distance (fig 4). The tegmen, as has already been mentioned, showed an abnormally deep origin from the lateral labyrinthine wall, going off just above the niche of the oval window. The facial nerve then entered the middle ear and lay for a short distance in an osseous canal on the under surface of the tegmen near its point of origin (figs 5 and 6). The nerve then, instead of going downward and backward over the postero-superior circumference of the oval window frame, turned downward and laterally

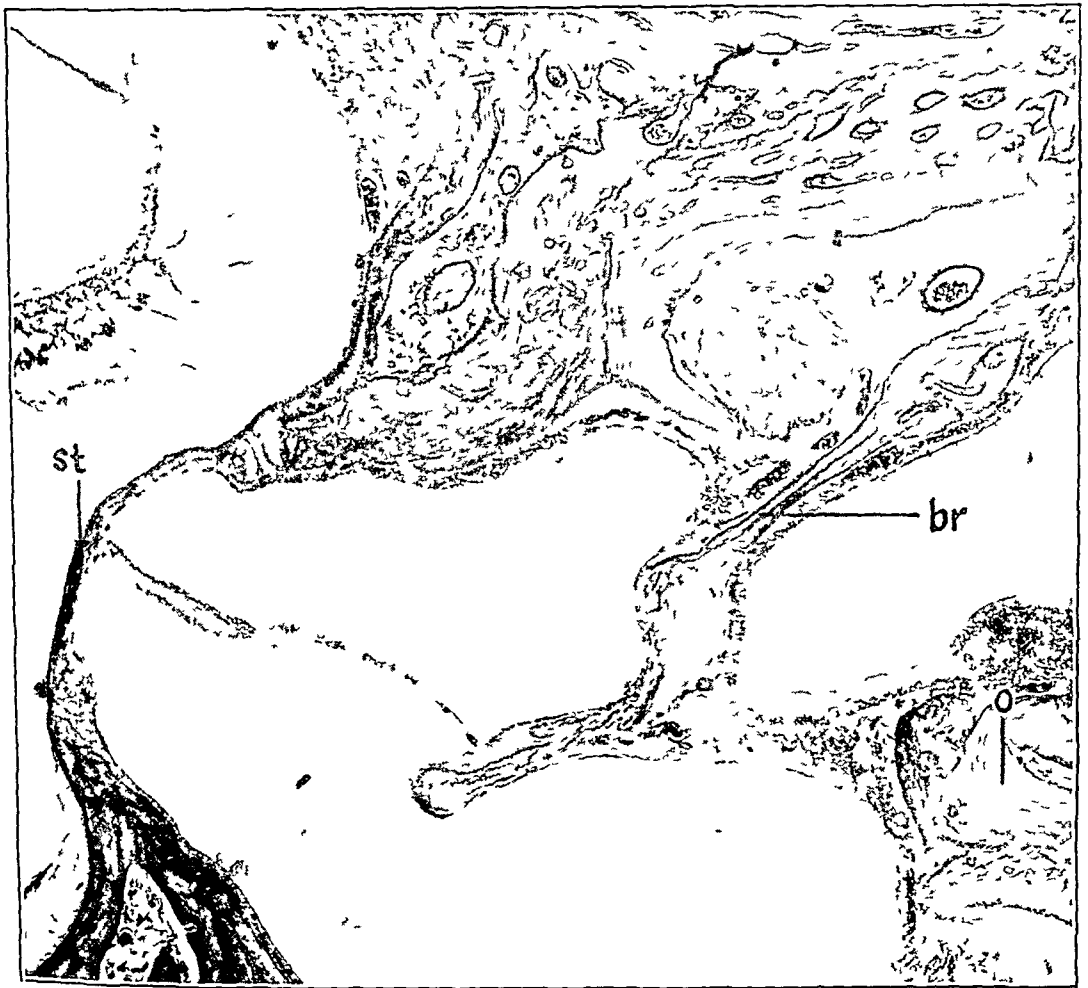


Fig 6—Osseous bridge (*br*) between the capitulum of the stapes and the facial canal, *o* indicates the outer ossicle and *st* the stapedial footplate

It was partially enclosed, running in an incomplete bony canal on the crest of a bony ridge which originated from the posterior part of the petrosum. The ridge extended from this point in an oblique direction anteromedially from the lateral to the medial wall of the middle ear and divided it into two parts: a supero-lateral compartment, which contained the antrum, and an inferomedial one, which contained the posterior recessus of the lumen of the middle ear, which has already been described. The nerve left the middle ear at a point which was farther forward and higher than usual. There it lay above the posterior process of the styloid (fig 5). Immediately after leaving the middle ear, the facial nerve gave off

the chorda tympani and then ramified in the usual way. The chorda tympani ran forward on the lateral side of the upper part of the styloid and eventually joined the lingual nerve (fig 1 to 4).

The tympanic nerve originated, as usual, from the glossopharyngeal nerve, penetrated the floor of the middle ear and formed a plexus (fig 3) over the promontory which was connected with the carotid plexus through two branches. The lesser superficial petrosal nerve was missing.

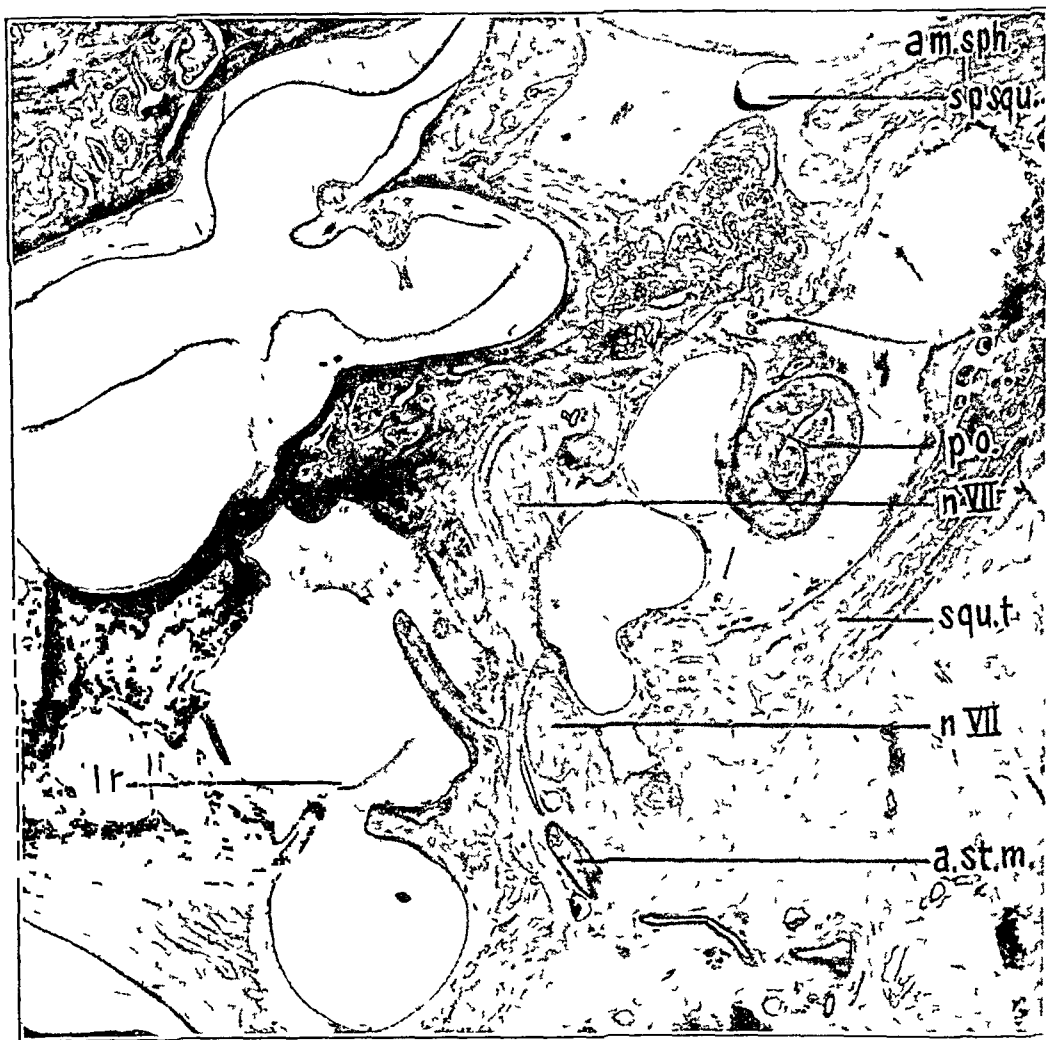


Fig 7—Section through the facial nerve crossing the middle ear on the crest of a bony ridge. The abbreviation *a m sph* indicates the greater wing of the sphenoid, *a st m*, stylomastoid artery, *l r*, lower recessus of tympanic cavity, *n VII*, facial nerve, *p o*, posterior process of the outer ossicle, *s p squ*, petrosquamous sinus, and *squ t* temporal squama extending far downward.

Blood Supply—The blood supply of the middle ear did not show any particular abnormalities. The internal carotid artery was of normal width and occupied its usual place. The trunk of the middle meningeal artery could not be found in the serial sections through the temporal bone, and the foramen spinosum was absent. In many of the sections arterial branches were seen on the outer surface of the dura, these seemed to represent branches of the middle meningeal artery, but

their place of origin could not be determined. The superficial petrosal branch in normal cases originates from the middle meningeal artery, enters the facial canal through the hiatus and anastomoses with the terminal twigs of the stylomastoid artery (fig 7). In this case, however, it originated in the internal auditory artery and accompanied the facial nerve on its way from the internal auditory meatus to the middle ear (fig 3).

The petrosquamous sinus was well developed (figs 1 to 7) and left the cranial cavity through the posterior part of the foramen ovale.

Inner Ear—The osseous capsule showed normal configuration. It contained an ovoid-shaped cartilage "rest" in its posteroinferior part. It lay in the outer parts of the enchondral layer (fig 3) and extended from there to the periosteum at the anterosuperior circumference of the jugular foramen in a posteroinferomedial direction through the periosteal layer. At its base, it showed progressive ossification from the enchondral layer. That part which bulged into the periosteal layer was covered with a thin layer of connective tissue, and there was no connection between the cartilage and the surrounding bone.

The membranous labyrinth showed no abnormalities.

Right Temporal Bone (horizontal serial sections)—All parts showed normal configuration and structure. The middle ear cavity showed a very well developed lumen, on this side, too. The large cartilage rest described on the left side could not be seen.

Summary of Anatomic Findings—Briefly summarized, there was in this case a normal right ear and the following malformation of the left ear: moderately severe malformation of the auricle, complete absence of the external auditory meatus and the drum membrane, absence of the tympanic bone with downward extension of the squama and upward extension from the floor, hypoplasia of the anterior part of the squama with backward extension of the greater wing of the sphenoid underneath the squama, a low origin of the tegmen from the lateral labyrinthine wall, hypoplasia of the osseous portion of the tube, opening into the lower portion of the well developed middle ear lumen, with the upper part of the latter forming an anterior recessus, upward and forward extension of the slightly hyperplastic upper end of the styloid process which is fused with a malformed outer ossicle replacing malleus and incus, connection of the malformed outer ossicle and of the capitulum of the stapes with the wall of the facial canal, hypoplasia, lateral displacement and abnormal insertion of the tensor tympani muscle, an anomalous muscle in the tegmen, anomalous course of the facial nerve through the middle ear, absence of the lesser superficial petrosal nerve, absence of the foramen spinosum and anomalous course of the middle meningeal artery, origin of the superficial petrosal arterial branch from the internal auditory artery, well developed petrosquamous sinus, leaving the cranial cavity through the foramen ovale, absence of the parotid gland, and a large cartilage "rest" in the enchondral part of the osseous labyrinthine capsule near the anterosuperior circumference of the jugular foramen.

The malformations of the ear were associated with bilateral cleft palate and multiple anomalies of the inner organs.

COMMENT

Most of the malformations just enumerated can be explained as the result of developmental disturbances of the derivatives of the posterior ends of the first and second branchial arches, of the adjacent structures and of the first branchial pouch and cleft.

Abnormal differentiation of the upper end of the branchial cartilage of the first arch was what led to the formation of the anomalous outer ossicle, which evidently represented the fused incus and malleus. It consisted mainly of the incus, which showed a well recognizable short and long process, and a body, with which the head of the malleus was fused. The manubrium, short process and anterior process of the malleus were absent. Lack of formation of the membranous bones in the neighborhood of the upper end of Meckel's cartilage undoubtedly caused the absence of the tympanic ring and the anterior process of the malleus. The place usually occupied by the tympanic ring was partly filled by a short downward extension of the squama and a short bony lamella extending upward from the lateral edge of the bony floor of the middle ear. The malformation of the upper end of the branchial cartilage of the second arch chiefly affected the upper end of the main part of this second arch, the so-called laterohyal and the upper end of the so-called stylohyal.

In normal circumstances the laterohyal forms the eminentia styloidea and participates in the formation of the lower part of the facial canal, from the stylohyal the styloid process is derived. The upper end of the laterohyal fuses with the labyrinthine capsule after the disappearance of its connection with the stapes (interhyal), the lower end fuses with the upper end of the stylohyal. It seems that in the case being discussed the upper end of the laterohyal did not fuse with the labyrinthine capsule, instead, it had grown forward and upward toward the incudomalleolar anlage and eventually fused with it. It did not participate in the formation of the facial canal and could not possibly have done so, even if it had remained in its normal location, because of the abnormal course of the facial nerve. The border between the laterohyal and stylohyal was most probably located at the place where the cartilage bar changed its course from backward and upward to upward and forward.

The disturbances in the development of the branchial skeleton also led to anomalies in the connection between the anlage of the incus and stapes, which, as a rule, is already present in early embryonic life (embryos of 17 to 18 mm). Instead of an incudostapedial joint, a bony bridge from the lower end of the incus and from the capitulum of the stapes to the medial tympanic wall was formed.

The hypoplasia and the abnormal course and insertion of the tensor tympani muscle point to disturbances in the differentiation of the mesenchyme of the first branchial arch from which this muscle develops. The anomalous muscle in the tegmen indicates by its innervation through a branch of the trigeminal nerve that it was derived from the same source. I have observed similar muscles in other malformed temporal bones (Altmann, 1932).

The abnormal course of the facial nerve, the nerve of the second branchial arch, was evidently a consequence of the abnormal developmental changes within the latter

The abnormal course of the middle meningeal artery, with the consequent absence of the foramen spinosum, can also be explained through anomalies within the second branchial arch. The middle meningeal artery is originally a branch of the stapedia artery, which takes its origin from the so-called later hyoid artery (Altmann, 1947)

It is impossible to state where the middle meningeal artery entered the middle fossa in the case described in this paper. In 2 cases with absence of the foramen spinosum (Toida, Low),⁴ it was assumed that the artery had originated from the sphenomaxillary portion of the internal maxillary artery, had entered the orbit through the inferior orbital fissure and from there the middle fossa, either through the superior fissure or the foramen meningo-orbitale in the greater wing of the sphenoid

The origin of the superficial petrosal branch from the internal auditory artery instead of from the middle meningeal artery deserves special attention. Origin of the entire middle meningeal artery from the internal auditory artery has been described previously by me (Altmann, 1932), also in a malformed temporal bone. This has been explained as a persistence of a so-called presegmental artery accompanying the acousticofacial nerve, with formation of a connection between this vessel and the supraorbital branch of the stapedia artery (Altmann, 1947). Although the condition in this case cannot be completely clarified, it seems very probable that the superficial petrosal branch here represents a persistent presegmental acousticofacial artery. This persistence seems to have been combined with anomalies in the junction of the anastomotic branch between the external carotid artery and the stapedia artery. This anastomotic branch later became the internal maxillary artery.

A persistent petrosquamous sinus is relatively frequent, even without any other malformations (Zuckerkindl, Knott, Cheatle, Streit Vernieuwe, Laff and others). After leaving the lateral sinus, it usually crosses the ridge of the petrous bone, follows the course of the petrosquamous fissure and leaves the middle fossa either through the spurious jugular foramen or with the middle meningeal vein through the foramen spinosum or, in rare instances, through the mastoid foramen. Departure through the foramen ovale, as found in the case described in this paper, has not yet been reported so far as I am aware.

Absence of the lesser superficial petrosal nerve is not uncommonly observed in such malformations (Altmann, 1933).

It cannot be decided whether the parotis was actually completely absent or only hypoplastic, as reported in some cases by me (Altmann, 1933).

In the malformation of the auricle both the mesenchyme of the first and that of the second branchial arch, which normally form the auricle, participated. The latter was only slightly smaller than normal in the case presented here, the different parts could be recognized, and a real defect was not found. These conditions represent a so-called first degree of microtia (Marx).

The absence of the external auditory meatus was due to the lack of development of the primary auditory meatus and of the meatal plate. Owing to the absence of the latter, which forms the inner part of the meatus, a drum membrane was not formed.

The hypoplasia of the osseous eustachian tube was due to an impeded development of the tubotympanic pouch. When considering the condition of the middle ear, one must distinguish between the anlage as a whole and the epithelium-lined cavity, the actual derivative of the first branchial pouch. The middle ear anlage in this case was smaller than usual and especially showed a diminished width. This is easily demonstrated by the fact that structures which normally are found within the cavity, such as the chorda tympani, were here found outside of it. The height of the anlage was also diminished, as evidenced by the low origin and the downward slanting course of the tegmen.

Notwithstanding the hypoplasia of the whole anlage, the epithelial part showed the same excellent pneumatizing power as on the other side. The combination of the marked pneumatizing power with the primary hypoplasia may account for the formation of the anterior tympanic recessus and the atypical opening of the tube into the middle ear cavity.

A review of the reported observations reveals the interesting fact that in almost all the cases with hypoplasia of the middle ear, alone or together with hypoplasia of the tube, there was a mastoid process of normal size and, as a rule, with good development of the pneumatic cells. This is regarded as due to the effect of a localized damaging factor which acts on a circumscribed area only (Altmann, 1933).

The cartilage "rest" in the enchondral capsule was due to a retardation of the ossification in a localized area of the capsule. I have observed similar foci in other instances also (Altmann, 1932).

Associated with the malformations of the two branchial arches were disturbances in adjacent parts of the skull, hypoplasia of the squamosum with normal development of the zygomatic portion and excessive growth of the greater wing of the sphenoid.

An excessive backward extension of the greater wing of the sphenoid beyond the anterior border of the squama had been described previously by me in malformed temporal bones (Altmann, 1933). In these cases the squama was either hypoplastic as in the observation described in this paper, or normal in size.

An explanation of this anomaly is difficult. Comparative anatomic studies have shown that the lateral part of the middle fossa of the mammals represents a region which in lower vertebrates is outside the cranial cavity. Because of the marked increase in size of the brain in mammals, the original lateral cranial wall has disappeared and the brain has been extended into an area which originally was situated outside the primordial cranial cavity. A secondary lateral wall of the cranial cavity is thus formed by the greater wing of the sphenoid bone (Matthes, Stadtmüller). The squamosum which in lower vertebrates is a membranous (dermal) bone of the otic capsule and of the palatoquadrate bar, retains in mammals also its relationship to the otic capsule, for it becomes intercalated between the parietal bone, petrous process of the temporal bone and the greater wing of the sphenoid. Its participation in the formation of the lateral wall of the skull shows great variations, however, in different species of mammals. It is, for example, almost completely excluded from the skull in Ruminantia and Cetacea but participates extensively in others (Stadtmüller).

It is possible that the anomaly in question reflects the fact that the participation of the squamous process in the formation of the lateral wall of the skull is not a primitive condition but a later acquisition of the mammalia which shows a great variability in the different species.

Complete absence of the external auditory meatus, as in the case just described, is the most frequent finding in congenital atresia. In others the outermost part of the meatus is present.

In one group of cases, however, which represent the mild degree of malformation (Altmann, 1933), either the entire canal, although hypoplastic, or at least its inner part, is present. The tympanic bone is hypoplastic and somewhat misshapen and the drum membrane smaller than normal. The tympanic cavity is normal in size or hypoplastic. Its contents show malformations of varying degree.

Altogether 15 sufficiently well described cases (17 temporal bones) have been reported (summarized in the table).

The cases in which the external auditory meatus was completely absent, possibly with exception of the outermost part, I have divided into two groups, representing the medium and severe degree of malformation (Altmann, 1933).

The severe degree, which is of less interest in this connection, is represented by 10 cases in which the tympanic cavity was completely absent or extremely hypoplastic (the table).

The medium degree, to which the case described in this paper belongs, shows the greatest structural variations. The tympanic cavity is as a rule, diminished in size and its contents deformed in varying degree. The lateral wall of the tympanic cavity forms the so-called atresia plate which is either completely or partly osseous. The tympanic

bone is present in some cases and missing in others. If it is present, it is badly misshapen, often platelike, frequently it contains at its center a membrane-like mass of connective tissue which is continuous with the connective tissue occupying the place of the missing external auditory meatus.

Regardless of whether a malformed tympanicum is present or not, the upper end of Reichert's cartilage might show anomalies. It might be abnormally situated and hyperplastic and might form the main part of the atresia plate. It is difficult to determine which particular part of Reichert's cartilage is malformed, particularly in older subjects, in whom extensive ossification has already taken place.

Cases of Congenital Atresia, Grouped According to the Severity of the Malformations and According to the Structure of the Atresia Plate

Malformations of Mild Degree	Malformations of Medium Degree					Malformations of Severe Degree
	Malformed Tympanic Bone Present		Tympanic Bone Absent			
	Atresia Plate Formed by the Tympanic Bone	Atresia Plate Formed by the Tympanic Bone and the Upper End of Reichert's Cartilage	Upper End of Reichert's Cartilage Hyperplastic	Reichert's Cartilage Not Hyperplastic, Processes from the Squama and the Tympanic Floor		
Heusinger (right and left)	Ranke (case 2)	Luscher (case 1)	Alexander and Benesi (case 1)	Sailly	Lucas	
Hyrtil (case 1 to 3)	Broca and Lenoir		Marx (cases 1, 2)	Hagens, 1932, 1933	Virchow, 1864	
Birnbaum	Hoepfner		Altmann, 1933 (cases 3, 4, right and left, 5, 6, right and left)	Altmann, 1933 (cases 7, 8 right and left)	Wreden	
Meyer	Takanarita		Kelemen	Cantele	Moos and Steinbrügge	
Landauer	Arione (left)		Altmann (present case)	Ricci	Ranke (case 1)	
Kaufmann (case 2, left)	Marx, 1926				Kaufmann (case 2, right)	
Krampitz (right)	Lüscher (case 2)				Marian and Delille	
Alexander and Benesi (case 2)	Fraser and Davis (left)				Leblanc	
Arlone (right)	Precechtel				Hofmann	
Altmann, 1933 (case 1, right and left, case 2, left)	Bruhl (right and left)				Altmann, 1933 case 2, right)	
Nager (left)	Nager (right)					
Druss and Allen						

A review of the suitable cases shows that in some of them, such as in the observation reported in this paper, the laterohyal had grown upward and forward toward the tegmen and the outer two ossicles. In others, the hyperplasia and the anomalous growth were found to have affected the upper end of the styloid process, as pointed out by Marx. In rare instances the laterohyal was malformed but in its normal place (Altmann, 1933, case 6, both sides). In order to avoid misunderstandings, it must be stressed that the term laterohyal is here used according to Broman, who designated by this term the part of the branchial arch skeleton which lies laterad to the facial nerve and which, in normal circumstances, connects the labyrinthine capsule with the main part of the branchial skeleton, with the stylohyal. It seems logical to agree with Marx that it is not permissible to call all the derivatives of Reichert's

cartilage with the exception of the stapes, laterohyal, as Alexander and Bénesi and other authors have done. In some of the observations, such as those described in this paper, the descending part of the facial nerve takes an anomalous course and leaves the middle ear at a point more forward and upward than usual, in others, its course is more or less normal. Since the laterohyal normally plays an important role in the formation of the lower part of the facial canal, the change in the course of the facial nerve might point to anomalies of the laterohyal, particularly in those instances in which the lower part of the nerve shows an anomalous course. In these cases the laterohyal may possibly participate in the formation of the atresia plate, in the cases with a normal course of the nerve, it seems more probable that the styloid alone is malformed.

The chorda tympani, in the course of normal development, always lies laterad to Reichert's cartilage. It has been shown by Marx that in cases in which the atresia plate is formed by the hyperplastic upper end of Reichert's cartilage alone the chorda is to be found running along the outer surface of the plate. This was also true in the case reported in this paper. It is self evident that the plate in these cases does not occupy the site of the tympanic membrane but lies mediad to it and that the tympanic cavity represents only the medial part of the tympanic cavity of normal ears.

If the tympanic bone is defective, outgrowths are formed from the squama and from the floor of the tympanic cavity, which extend downward and upward respectively and diminish or close the defect of the lateral wall. The development of these two processes seems to be in inverse proportion to the degree of enlargement of the uppermost part of the skeleton of the second branchial arch. It takes place gradually during fetal and postfetal life and most probably represents a proliferation *ex vacuo* into the space normally occupied by the tympanic bone. From the course of the chorda tympani in cases without hyperplasia of Reichert's cartilage, it may be concluded that there the atresia plate usually lies more medial than the normal drum, but not so far medial as the hypertrophied upper end of Reichert's cartilage (Altmann, 1933).

Altogether 28 cases (32 temporal bones) belonging to the second degree of malformation permit a detailed genetic analysis of the atresia plate (the table). In 12 of them a malformed tympanic bone was present. In 11 the atresia plate was formed by the tympanic bone alone or together with a mass of condensed connective tissue. In 1 case the plate was formed by the tympanicum together with the hyperplastic upper end of Reichert's cartilage. In 16 cases, the tympanic bone was completely absent. In 9 of them, the upper end of Reichert's cartilage was hyperplastic (laterohyal or stylohyal), in addition, there might be formation of processes from the squama downward and the floor of the

tympanum upward In 7 cases there was no hyperplasia of the derivatives of the second branchial arch but only formation of processes from the squama and the floor of the tympanum

Malformations of the ossicles, particularly of the malleus and incus, are commonly observed in such cases Of special interest with regard to the possibility of improvement of hearing through surgical procedures is the presence of bony bridges between the medial wall of the promontory and the malformed outer ossicle and the head of the stapes Both types of bridges were also present either singly or combined in several other cases reported in the literature

Malformations of the inner ear were absent in the case described in this paper They were, however, found in one third of the cases and showed a great variability in their location and degree

Although in the case in question the left ear was malformed, the right side is, as a rule, much more frequently affected This is shown even in prehistoric skulls afflicted with this malformation (Hrdlička) No satisfactory explanation has yet been given for the predominance of the right side

There is no definitely proved sexual incidence in these malformations

The evidence of heredity is somewhat scanty, at least in man (Sedgwick, Windle, Krampitz, Torrigiani, Frenzel, Eckert-Mobius, Schwarz) In animals, among which cases have been reported in pigs, goats, sheep, cattle, horses, hares, rabbits and mice, there is definite evidence of hereditary transmission in many instances, in mice the inheritance of congenital atresia follows a recessive trait (Feldman)

Very often, as in the case described in this paper, the malformations are not confined to the ear but affect adjacent parts of the skull, other parts of the branchial arches, the second branchial pouch or other structures of the head The following malformations should be mentioned hypoplasia of the mandible, alone or combined with other malformations of the face (dysostosis mandibulofacialis—Franceschetti and Zwahlen), defective development of the ramus mandibulae and the temporomandibular joint, hypoplasia or defect of the zygomatic arch, hypoplasia of the hard palate, hypoplasia or defect of the velum palatinum, absence of the anterior tonsillar pillar and of the tonsil, teratoid tumors originating from the tonsil, heterotopic thymus tissue in the middle ear, fissures of the face, particularly transverse fissure, cleft lips and palate, hypoplasia of one half of the face (facial hemiatrophy) sometimes combined with congenital facial paralysis, choanal atresia, hypoplasia of the parotid gland, coloboma of the eyelid or congenital narrowing of the lid cleft

In addition, accompanying malformations in other, more remote internal organs and in various parts of the skeleton are often found Among the skeletal malformations two will be mentioned because of

their relative frequency dysostosis craniofacialis (*maladie de Crouzon*) (Nager) and defects of the radius and the distal skeletal parts connected with it (Essen-Møller)

Because genetically different formations, which are nevertheless situated in the same area, are found to be malformed in cases of congenital atresia, one may believe that the malformations were caused by a damaging factor of unknown nature which was present in a circumscribed area during early development. Such a group of coordinated malformations confined to the same region comprise what Virchow called a *Störungskreis*.

The circumscribed area in which the effect of the supposed damaging factor becomes manifest is well demonstrated by the cases in which the tympanic cavity and the neighboring systems of pneumatic cells are poorly developed, but the eustachian tube, the antrum and the mastoid cells are normal. In such cases it can be assumed that the damaging factor has acted only in that portion of the tubotympanic tube which later becomes the middle ear.

The question of the cause of the congenital atresia of the ear remains undecided in spite of that increased knowledge of the physiology of early embryonic development which has greatly helped in the interpretation of many varieties of congenital malformations in this field. Our knowledge is based mainly on evidence gained from the results of experimental studies in lower vertebrates, particularly in amphibians. It was demonstrated by Spemann and his school that the normal development of the entire body takes place under the inductive influence of the so-called organizers. These are, generally speaking, areas of the embryo which exercise a specific regulatory influence on morphogenesis by producing certain chemical substances (evocators) which bring about the differentiation of the various organs and tissues. The primary organizer material is derived from the dorsal lip of the gastrula. It gives rise to a head organizer, which induces the differentiation of head, brain and sense organs, and to a trunk organizer, which induces the differentiation of the trunk. In the course of this embryogenesis, organizers of lower grade (secondary, tertiary, etc.) are formed. These exert a more limited and specific inductive influence on organ and tissue differentiation in successive developmental stages. The ear vesicles develop under the inductive influence of a second grade organizer of the hind-brain and the head mesoderm, the primary inductor seems to be the head mesoderm (Harrison, Pasteels and others). The otic capsule is induced by a third grade organizer, the otocyst and its derivatives. Keller, after a review of the literature and a genetic analysis of typical malformations of the head in rabbits, came to the conclusion that the development of the head in mammals is governed by the same principles as in amphibians. According to him the development depends on the

presence of normal organizers, if the latter are damaged, faulty development of the affected areas will be the result

Among the various factors which could exert a damaging influence on mammalian organizers, the genetic factors should first be mentioned

Gene mutations occur not infrequently in mammals, including man. If they lead to malformations which are incompatible with life, they are called lethal, if they lead to early death, they are called sublethal mutations (Wriedt, Eaton, Mohr, Lerner, and others). The abnormal genes show a specific action on certain areas and at certain stages of embryonic development (primary organizer, second grade organizers, etc.) (Toendury)

The combination of atresia of the ear with other malformations in the head region can be regarded as organizer damage with subsequent manifestation in various parts of the head. Combinations of atresia with malformations of other parts of the body could be accidental, if they occur frequently, such as combination of congenital atresia with defects of the radius, the possibility of gene linkage should be considered, particularly if the malformations are of a hereditary nature. In other instances, a single gene has been shown to produce a wide variety of effects, some of which may be shown to be caused by others but the totality of which is difficult to relate to any common factor. In these cases with "pleiotropic" gene action, it is likely that the fundamental anomaly is metabolic, manifesting itself in different ways (Needham). Not all the syndromes of multiple congenital defects, however, are genetically determined. Environmental interference with the early development of the embryo may also result in multiple congenital malformations. Repeated appearance of congenital malformations in a pedigree may be due not only to inheritance of abnormal genes but also to repeated exposure of developing embryos to the same adverse environmental factors.

The normal mode of action of the genes depends on the presence of normal relation between nucleus and cytoplasm and of normal environment. Anomalies, not only of the genes but also of one of the other factors, may result in faulty differentiation. In certain instances the same type of malformation can even be produced by anomalies of either the genes or the other factors, here the malformations are called phenocopies.

Among the environmental factors which may produce malformations in mammals, the chemical factors are of particular interest. The action of trypan blue deserves special attention because it frequently produces congenital atresia of the ear.

Gillman and his collaborators found that the subcutaneous injection of 1 cc. of an aqueous solution of trypan blue every two weeks into female rats before conception and pregnancy led to a high incidence of such

congenital malformations as hydrocephalus, spina bifida, eye defects, and a lesser incidence of tail defects, meningocele, harelip, cleft palate, cranioschisis, ear defects, imperforate anus, club feet and dislocations of the forelimbs and hindlimbs. If the animals received the injections on the seventh or sixth day before conception as well as on the seventh or eighth day of pregnancy, the incidence of malformations was 80 per cent in the former instance and 65 per cent in the latter.

Malformations of the ear were found in 59 per cent of the total number of abnormal animals. The pinna was lacking altogether or was represented by a small tubercle. No external auditory meatus could be detected. In 1 case an additional tubercle was present on the pinna of the ear. The malformed ears were either solitary or combined with other malformations, such as hydrocephalus, defects of the eyes or both or with defects of the skull.

Trypan blue is absorbed by the albumin fraction of the plasma protein and produces a metabolic disorder in the animals given the injections. The dye does not enter the fetus, so the malformations were evidently a result of metabolic disease in the mother. The fact that the highest incidence of malformations occurred when the mothers were given injections on the seventh or eighth day of pregnancy does not necessarily mean that certain tissues of the embryo are more vulnerable at certain developmental periods than at others. The supposed metabolic disorder could lead to disturbances in the implantation of the embryo into the uterine wall, which takes place at that particular time, and which is a complicated process necessitating various types of adjustments in the embryonic membranes and in the maternal tissues. It is much easier to relate the critical period of vulnerability of the rat embryo to the time of implantation than to the degree of growth and differentiation of those primordia which later undergo a perverted development. Changes in the metabolism of the chorionic villi at this early stage, for example, may profoundly modify the subsequent growth of the embryo and lead to malformations.

In other instances chemicals may exert an injurious influence on second or third degree organizers or their evocators which regulate the embryonic development in the later stages.

Infectious factors may also affect the embryo. One disease, maternal rubella, is of particular interest for the otologist.

Gregg was the first to notice that infection with German measles in the first months of pregnancy led to anomalies in the offspring in a great number of instances. The defects were located mainly in the central nervous system, the sense organs (eye, ear), and the heart, less frequently in other organs, e. g. the teeth.

The histologic examination of one ear by Carruthers, although an incomplete one, showed that the changes were confined to the membranous parts of the inner ear.

Nothing definite is known yet of the mode of action of the rubella virus

Nutritional factors also seem to play an important role, although so far only malformations of the auricle have been produced in this way in a few instances

Vitamin A deficiency in the diet of pregnant animals leads to various malformations in the offspring. Hale produced anophthalmia, microphthalmia, accessory auricles, cleft palate and lip, subcutaneous cysts and displaced kidneys in pigs. Warkany and Schraffenberger observed malformations of the eye with associated thoracic and abdominal abnormalities in rats.

Riboflavin deficiency leads to multiple skeletal deficiencies in rats, including cleft palates (Warkany and collaborators).

Irradiation of pregnant mice and rats with roentgen rays and radium results in various malformations in the offspring, such as defects of the eyes, the brain (pseudencephaly) and the skeleton, including cleft palate, etc. (Bagg, Bagg and Little, Bailey and Bagg and others). These malformations are regarded as due to the direct effect of the rays on the tissues of the embryo. Gillman and his collaborators recently reconsidered the possibility of an indirect effect from the radiation, leading primarily to metabolic disturbances of the mother.

Irradiation of male animals may result in hereditary changes in the offspring, but these are regarded as the result of reciprocal gene translocation rather than of gene mutation (Snell and collaborators, P. Hertwig). Marked anomalies of the brain may be found, in other instances anomalies of the ears were produced (spinning and shaking mice with syndactylism, P. Hertwig).

The importance of mechanical factors, such as amniotic bands or adverse mechanical conditions during ectopic pregnancy, seems to have been overestimated in the past. Since the discovery of other causative factors, less emphasis has been placed on mechanical ones.

A summary of the foregoing material shows that congenital atresia of the ear need not necessarily and invariably be the result of genetic changes, there are good reasons for assuming that in certain instances metabolic disturbances during early pregnancy may produce the same type of malformations, sometimes even in combination with other, seemingly unrelated, anomalies.

Even in a case such as the following one recently observed in Babies Hospital, no definite decision about the etiology can be made.

A woman gave birth to a girl with multiple malformations, among them bilateral cleft lip and palate and atresia of the anus with rectovaginal fistula. One year later, she again gave birth to a girl with multiple malformations, among them there was again bilateral cleft palate, atresia of the anus with rectovaginal fistula and, in addition, multiple malformations of the eyes and bilateral atresia of the external auditory meatus.

A carefully compiled family history revealed the following facts. The father was 31 years of age, the mother was 35 years of age and both were in good health. The father was in the South Pacific during the war and had "dengue and yellow jaundice" there. There was, however, no recurrence of either. There was no history of venereal diseases, exposure of either parent to roentgen rays, radium or atomic energy. Both pregnancies ended at full term, there were no diseases during pregnancies, no abortions and no miscarriages. There was no evidence of malformations in the father's family for five generations or in the mother's family for four generations. The paternal grandfather had a mild diabetes of twelve years' duration. No family history of allergies or of gastrointestinal or genitourinary diseases was obtained.

The assumption that the malformations in this case are caused by a recessive sublethal gene is very tempting, but, as has already been stated, repeated exposure of developing embryos to the same adverse environmental factors may have the same effect.

The hearing in cases of congenital atresia, aside from the severity of the malformations of the external and middle ear, depends on the condition of the inner ear. If the latter is intact, the hearing is, as a rule, not too severely impaired, hence, even in cases of bilateral involvement, ordinary conversation can be understood well enough. As a result, the development of speech in the child will be unhampered. If, however, the labyrinth is also affected, the hearing loss will be more profound.

Attempts to improve the hearing in congenital deformities by operative intervention should be confined to cases in which one can be reasonably sure that the inner ear is intact. But even in these cases the optimism of many authors regarding the chances for success seems hardly justified. Because of the great variety of changes in the middle ear, it is practically impossible to recognize those cases which are apt to respond to surgery with a reasonable degree of certainty. Those who are thoroughly familiar with the anatomic changes in these cases will be able to determine in a certain number of instances, by a combined clinical and roentgenologic examination, the approximate type of malformation (Politzer and Mayer, Mittermaier, Leroux and Cottenot, Camp and Allen and others) but not the exact condition. Minute deformities will, as a rule, escape detection, they are, however, sometimes of decisive importance in determining the extent of improvement in hearing to be gained by surgery. Fixation of the stapes, that is, by bony bridges to the medial wall or bridges between the outer ossicles and the medial, superior or outer wall, would remain undiagnosed by present methods of clinical examination.

In cases with unilateral malformation the necessity of improving the hearing will rarely arise and an operation will be unnecessary unless a surgical mastoiditis has developed or a congenital cholesteatoma is present or suspected. In cases with bilateral malformation and seem-

ingly intact inner ears, a bone conduction aid might, in view of the uncertainty of the success of an operation, be preferable in many instances. If, however, an operation is decided on, the technic must be varied in detail, according to the special conditions met in each individual case.

The principle of these operations consists in opening of the mastoid through a retroauricular or an endaural incision (Pattee) or through a combined retroaural and endaural incision (Ombredanne). Then the mastoid cells, if present, are removed, the antrum located and opened, the lateral semicircular canal identified and the outer ossicles visualized. Removal of at least the incus seems essential for the success of the operation, because with the drum membrane almost invariably absent and the ossicles practically never free of at least minor malformations, the ossicular chain, even if present in all its parts, serves no useful purpose and may, indeed, impede the transmission of air-borne sounds to the inner ear. This is particularly the case when bony bridges are present between the malleus or incus and the walls of the middle ear. The main danger in the postoperative course is the tendency of the newly created opening into the mastoid to narrow and close. Retention of secretions in the operative cavity with all its consequences will be the result. In order to prevent this most undesirable development, a plastic flap is formed, however, because of the absence of the skin of the external meatus, the flap will be small and in many instances insufficient to prevent eventual closure of the opening. It is, therefore, advisable to cover the operative cavity with Thiersch grafts which are kept in place, according to most authors, with packings. Pattee opens the antrum just far enough to remove the incus. Thiersch grafts are then placed in the cavity and over the opening into the middle ear. The edges of the graft are then sutured to the edges of the skin incision. The grafts are kept in place by wet cotton packing, which is removed after five to seven days. If the opening into the middle ear is not too large, the middle ear mucosa grows quickly over the unlined under surface of the graft, according to this author, otherwise it would slough. Ombredanne has suggested the use of a Stent mold to keep the cavity open. In a case in which I operated, a paraffin mold of the cavity was first made and then the cavity was refilled with melted paraffin. The paraffin mold was then reproduced in acrylic resin, the paraffin was removed from the cavity and the surface of the acrylic mold covered with Thiersch grafts and put back into the cavity. The acrylic mold was worn by the patient until the cavity was completely epithelized.

But, even if all the necessary precautions are taken and the technical result is perfect, the hearing still remains unimproved in a considerable number of cases, including those in which fixation of the stapes or other abnormalities in the windows and their niches are present. I cannot,

therefore, agree with Pattee's claim that after an operation "theoretically, therefore, the hearing should be improved to about the level expected from the fenestration operation"

Ombredanne (1947) recently advocated in cases of congenital atresia a fenestration of the lateral semicircular canal and covering of the fistula with a retroauricular skin flap. He reported good results in two operations performed in children.

Fenestration is undoubtedly of value in cases with fixation of the stapes but unnecessary in all the others. Because of the practical impossibility of differentiating clinically between the two groups, it seems preferable to do the usual operation first. If, after complete epithelization the hearing is not improved, a fenestration could be performed as a second stage operation. In this instance, the prospects of permanent patency of the fenestra would undoubtedly be much greater than in Ombredanne's one stage operation with a thick flap from the retroauricular skin.

The question of when and how a plastic reconstruction of the malformed auricle should be undertaken belongs, in all its technical and psychologic aspects, to the domain of the plastic surgeon and not of the otologist. It will, therefore, not be discussed here.

SUMMARY AND CONCLUSION

A histologic examination of a congenital atresia of the left ear in a newborn girl with multiple malformations showed complete absence of the external auditory meatus, the drum membrane and the tympanic bone, malformation of the outer ossicles and an osseous bridge between the capitulum of the stapes and the facial canal. The resulting defect in the lateral wall of the tympanum was partially filled by an upward and forward extension of the upper end of the styloid, a downward extension of the squama and an upward extension from the floor of the middle ear. In addition, many other anomalies were present.

Most of these malformations can be explained as the result of developmental disturbances of the derivatives of the posterior ends of the first and second branchial arches, of the adjacent structures and of the first branchial pouch and cleft.

Fifty-three sufficiently well described cases of congenital atresia have been reported so far. According to the severity of the malformations, they can be divided into three groups, those of a mild degree (15 cases), medium degree (28 cases) or severe degree (10 cases).

In the cases of medium degree, to which the case described in this paper belongs, the lateral wall of the tympanum, the so-called atresia plate, shows great structural variations. The tympanic bone, although malformed, participated in its formation in 12 cases and was absent in 16 cases. In 9 of the latter cases the upper end of Reichert's cartilage

was hyperplastic, in 7 there was only formation of processes from the squama and the floor of the tympanum

Hypertrophy of the upper end of Reichert's cartilage is a relatively frequent feature but not an essential characteristic of these malformations, as is assumed by some authors

The cause of the malformations remains undecided. A review of the more recent work on experimental mammalian teratology shows that not only genetic but also environmental factors acting on the developing embryo must be considered as possible causes

The chances for an improvement of hearing by operative intervention are doubtful, even in cases with an intact inner ear. This is due to the frequency of bony bridges between the stapes and the medial tympanic wall and to other minute deformities which might escape detection

If an operation is decided on, a radical mastoidectomy with endaural approach and removal of the outer ossicles seems the method of choice. Skin grafts should be put into the cavity and kept in place by a mold. This will help to prevent postoperative stricture of the newly created opening. If the hearing is not improved after the operation, the possibility of fixation of the stapes should be considered. This could be circumvented by fenestration of the ampullated end of the lateral semicircular canal in a second stage operation

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GLOSSOPHARYNGEAL NEURALGIA

Tic Douloureux of the Ninth Cranial Nerve

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TODAY, glossopharyngeal neuralgia is recognized as a major type of paroxysmal pain involving the distribution of the ninth cranial nerve. This has not always been so. For many years it was mistaken for trigeminal neuralgia, although the pain was not relieved by a partial or complete division of the posterior root of the gasserian ganglion.

The course of the glossopharyngeal nerve was described by Galen¹ and the nerve separated as a distinct entity by Fallopius, but the actual functions were unknown until recent years. In 1910, Weisenburg² described the symptoms of glossopharyngeal neuralgia due, in his case, to a tumor in the cerebellopontile angle pressing on the ninth nerve as shown at autopsy. Sicard and Robineau³ in 1920 described true glossopharyngeal neuralgia but were not certain of its purely ninth nerve origin. Doyle⁴ and Adson,⁵ of the Mayo Clinic, were the first to report cases⁴ and to operate⁵ in such cases in this country. Adson first tried the extracranial approach, but from his studies in the cadaver he advocated the intracranial approach for permanent cure. Love⁶

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1 Peet, M. M. Glossopharyngeal Neuralgia, *Ann Surg* **101** 256-268 (Jan) 1935.

2 Weisenburg, T. H. Cerebello-Pontile Tumor Diagnosed for Six Years as Tic Douloureux. The Symptoms of Irritation of the Ninth and Twelfth Cranial Nerves, *J A M A* **54** 1600-1604 (May 14) 1910.

3 Sicard, R., and Robineau. Communications et presentations. I. Algie vélopharyngée essentielle, Traitement chirurgical, *Rev neurol* **36** 256 (March) 1920, cited by Peet¹.

4 Doyle, J. B. A Study of Four Cases of Glossopharyngeal Neuralgia, *Arch Neurol & Psychiat* **9** 34-46 (Jan) 1923.

5 Adson, A. W. The Surgical Treatment of Glossopharyngeal Neuralgia, *Arch Neurol & Psychiat* **12** 487-506 (Nov) 1924.

6 Love, J. G. Diagnosis and Surgical Treatment of Glossopharyngeal Neuralgia, *S Clin North America* **24** 959-962 (Aug) 1944.

credited Adson (1925) and Peet¹ gave Dandy⁷ (1927) credit for the first successful intracranial section of the ninth nerve for true glossopharyngeal neuralgia. The excellent monographs by Doyle, Adson, Dandy and Peet are comprehensive.

Glossopharyngeal neuralgia (although far less common than fifth nerve tic) differs from trigeminal neuralgia in only one important point, the distribution of the pain. In some instances neuralgia of both the ninth and the fifth cranial nerve may exist simultaneously. Peet, in a series of 14 patients, noted that 5 of them had trigeminal as well as glossopharyngeal neuralgia.

SYMPTOMATOLOGY

In general, the symptomatology of glossopharyngeal neuralgia is uniform. This is not difficult to understand, inasmuch as the sensory distribution of the glossopharyngeal nerve has been shown⁸ to be the posterior third of the tongue, the lateral and posterior walls of the pharynx from the lower nasopharynx to the epiglottis, the tonsil, the anterior and posterior pillars, the orifice of the eustachian tube, the tympanic membrane (Jacobson's nerve) and a portion of the soft palate and uvula. Taste fibers supply the posterior third of the tongue. The trigger point is always in the distribution of the ninth nerve.

Severe paroxysmal pain is the outstanding feature of glossopharyngeal (tic) neuralgia. Talking, swallowing (especially cold liquids and ice cream), yawning, coughing, laughing or sneezing may precipitate the characteristic attack of sharp knifelike agonizing pain which usually lasts only a few seconds. In some instances the flashes of pain occur in succession for as long as two minutes. Intermission may vary from a few minutes to several hours or days. Remissions of weeks and months are common. A period of complete freedom from pain may exist for two or three years or longer.

DIAGNOSIS

The diagnosis of true glossopharyngeal neuralgia usually offers little difficulty. First, the complete history is obtained. In all the patients observed by us, attacks of pain occurred while the history was being obtained, thus presenting an opportunity for "on the scene" observation of the person's distress and behavior. Of the patients reported on here, all had unilateral distribution of the pain and, with but 1 exception, were very specific about the pain trigger zone.

7 Dandy, W. E. Glossopharyngeal Neuralgia (Tic Douloureux), *Arch Surg* 15:198-214 (Aug) 1927.

8 Doyle⁴, Adson⁵, Love⁶, Dandy⁷.

Once the history is obtained, a thorough physical examination is made. At the time of the initial examination, use of nasal or pharyngeal anesthetic solutions is avoided if possible. When no obvious local etiologic factor related to the ear, nose, throat or neck can be found, the patient is asked to keep a written record of attacks of pain for twenty-four hours, noting duration and degree of pain, variations of distribution, if any, and interval of time between attacks of pain. Thereafter, cotton pledgets soaked in a 10 per cent solution of cocaine or 2 per cent solution of tetracaine hydrochloride U S P (pontocaine hydrochloride®) and squeezed almost dry are applied directly to the region of the painful trigger zone as indicated by the patient. This procedure generally alters the pain within two or three minutes. Again the patient is requested to keep a written record of the attacks of pain for twenty-four hours. This permits a definite comparison and evaluation of the effect of anesthesia on the attacks of pain. Once the trigger zone is anesthetized, the paroxysms of pain are reduced in severity and in number for two to twelve hours or longer. Whenever any doubt exists about the diagnosis, this procedure may be repeated as often as necessary until a definite conclusion is reached.

DIFFERENTIAL DIAGNOSIS

In certain instances considerable study may be required for an exact diagnosis. In 1 of our patients the impression of the referring physician and the roentgenologist was that of a tumor of the upper portion of the esophagus because of apparent obstruction on swallowing (dysphagia). Barium sulfate could not be swallowed, leading the roentgenologist to believe that there was an obstructive lesion in the upper end of the esophagus. It was not until after esophagoscopy revealed the absence of an obstructing lesion that section of the left glossopharyngeal nerve was done. The patient could not swallow, not because of obstruction but because of severe pain in the throat.

There are several other lesions resembling tic which must be differentiated from glossopharyngeal nerve tic. 1 Tic douloureux of the third division of the fifth nerve. 2 Superior laryngeal nerve tic (vagus), as reported by Love⁸ and co-workers,⁹ causing external (lateral) throat pain. 3 Tic douloureux of the nerve of Wrisberg (nervus intermedius), or geniculate ganglion neuralgia, successfully operated on by Taylor¹⁰ in 1910 and by Furlow¹¹ in 1941. Furlow

⁹ Smith, L. A., Moersch, H. J., and Love, J. G. Superior Laryngeal Neuralgia, Proc Staff Meet, Mayo Clin **16** 164-167 (March 12) 1941.

¹⁰ Cited by Hunt, J. R. Geniculate Neuralgia (Neuralgia of the Nervus Facialis), Arch Neurol & Psychiat **37** 253-285 (Feb) 1937.

¹¹ Furlow, L. T. Tic Douloureux of the Nervus Intermedius, J. A. M. A **119**:255-259 (May 16) 1942.

was the first deliberately to divide the nervus intermedius only for tic of that nerve due to pain confined to the ear (sensory root of the seventh nerve) If the trigger point of the pain is in the tragus of the external ear, this type of tic is the most likely diagnosis 4 Neuralgia of the sphenopalatine ganglion (Sluder's) 5 Laryngeal crisis of tabes dorsalis 6 The syndrome of lateral granular pharyngitis There are two types of ninth nerve tic (a) that confined to the ear alone (rare without pain in the throat [Jacobson's nerve neuralgia]), due to the involvement of the tympanic membrane (not the external ear) by Jacobson's nerve (a branch of the ninth) rather than involvement of the entire ninth nerve, (b) the common type, in which the pain in the throat predominates and appears first and in which the pain deep in the ear develops secondarily or radiates from the throat Both of these types of ninth nerve tic are completely relieved by section of the ninth nerve alone, but when there is pain in the ear as well as in the throat it is probably better always to divide also the anterior two filaments of the tenth nerve (vagus) in every operation for ninth nerve tic

If one is in doubt, because of predominant pain in the external ear or tympanic membrane, as to whether the pain is due to involvement of the ninth nerve (Jacobson's nerve) or to tic of the nerve of Wrisberg, operation under local anesthesia is advisable, so that the pain can be demonstrated by touching each nerve in turn with a forceps and dividing the appropriate one Third division trigeminal nerve pain can be identified or eliminated by injection of alcohol, although it must be remembered that glossopharyngeal and third division (trigeminal) tic pain may occur simultaneously on the same side, as reported by Peet and Echols¹²

TREATMENT

There is no satisfactory medical treatment for glossopharyngeal neuralgia Hoover and Poppen¹³ found inhalation of trichloroethylene helpful for relieving the pain for two or three hours in 2 patients The application of local anesthetic agents, caustics and cautery treatments to the trigger zone may alter the attacks of pain temporarily but cannot be said to be curative Intracranial section of the glossopharyngeal nerve offers the most satisfactory procedure for complete and permanent relief of the pain and is the only positive method of preventing recurrence

12 Bancroft, F W, and Pilcher, C Surgical Treatment of the Nervous System, Philadelphia, J B Lippincott Company, 1946, p 283

13 Hoover, W B, and Poppen, J L Glossopharyngeal Neuralgia, J A N A 107 1015-1017 (Sept 26) 1936

In selected cases the operation can be performed with local infiltration anesthesia, but intratracheal administration of ether with tri-bromoethanol solution U S P (avertin®) is preferred. The operative approach is identical to that used for division of the eighth nerve in Ménière's disease, i e., a hemicerebellar exposure on the side of the patient's pain.

The dura is incised and the cisterna magna evacuated, followed by emptying of the cisterna lateralis. The auditory (eighth) nerve is usually identified first, but this is not essential. The ninth, tenth and eleventh nerves lie close together, about 1 cm caudad to the eighth. The ninth is usually identified easily but occasionally with difficulty, as it may be rather closely approximated to the branches of the vagus nerve, furthermore, the ninth may be bifid. When identified, the ninth nerve is lifted on a nerve hook and divided with scissors, scalpel or the electrosurgical current. The anterior two rootlets of the vagus are also severed if the patient has a history of flashing pain in the eustachian tube and ear as well as in the throat. Following section of the ninth nerve, which is ordinarily the simplest of all posterior fossa operations performed by the neurosurgeon, there may be a slight transient dysphagia or dysarthria for three or four days if vagal rootlets have been divided.

Because the nerve has been sectioned central to its sensory ganglion (petrous), there can be no regeneration, just as in tic douloureux of the fifth nerve, in which operation the sensory root is divided between the gasserian ganglion and the pons. The mucous membrane supplied by the ninth nerve remains permanently anesthetic, and the gag reflex on that side is lost. Subjectively, the patient is rarely, if ever, aware of this postoperatively. This is in contrast to the typical consciousness of facial anesthesia following operation for fifth (trigeminal) nerve tic. No motor weakness can be demonstrated. There are no residual subjective symptoms of any kind, with the result that, practically speaking, there is no penalty to the operation, as there so often is following other operations on the cranial nerve. The loss of taste sense on the posterior third of one side of the tongue is not noticed by the patient. Results are usually very satisfactory.

Dandy¹⁴ stated that in 2 of his early cases of glossopharyngeal tic the pain was diminished but not completely eliminated by cutting the ninth nerve only. The wound was reopened and the anterior filaments of the tenth nerve divided (one eighth to one sixth of the fibers of the tenth nerve), after which the pain was permanently abolished. At times both fibers (if the nerve is bifid) of the ninth nerve are incorporated with the tenth. Dandy in his last cases always divided the upper part (one sixth to one eighth) of the tenth nerve, no symptoms followed its inclusion in the section.

¹⁴ Dandy, W. E. *Surgery of the Brain*, in Lewis, D. *Practice of Surgery*, Hagerstown, Md., W. F. Prior Company, 1945, vol. 12, p. 188.

SUMMARY AND CONCLUSION

Glossopharyngeal neuralgia, or tic douloureux involving the glossopharyngeal nerve, has become a well established entity in the last twenty-five years. As a clinical syndrome it rightfully falls in the field of otolaryngology. However, since successful or specific operative treatment is the task of the neurosurgeon, most of the literature regarding this subject has appeared in medical literature other than that dealing with otolaryngology.

*Summary of Data on Eight Patients with Glossopharyngeal (Tic) Neuralgia Treated Surgically at the Medical College of Virginia from 1943 to 1948**

Sex	Age, Yr	Side	Duration of Symptoms, Yr	Distribution of Pain	Trigger Zone	Nerve Sectioned
M	30	L	5	Throat, ear	Tonsil fossa, lateral part of pharynx	Glossopharyngeal, vagus fibers
M	77	R	3	Base of tongue, lower jaw, ear	Tonsil fossa, rim of palate	Glossopharyngeal
F	62	L	4	Hypopharynx	Hypopharynx	Glossopharyngeal
M	39	R	3	Lower lateral part of pharynx, ear	Tonsil fossa, hypopharynx	Glossopharyngeal, vagus fibers
F	57	L	1	Posterior part of pharynx, rim of palate, ear	Tonsil fossa, palate, hypopharynx	Glossopharyngeal, vagus fibers
M	53	L	6	Lateral part of pharynx, ear	Lateral pharyngeal band	Glossopharyngeal
M	59	L	3	Ears, submaxillary triangles	Hypopharynx	Glossopharyngeal
M	50	R	1/2	Tonsil fossa, lateral part of pharynx	Tonsil fossa, lateral part of pharynx	Glossopharyngeal

* All patients were completely relieved, and no recurrence of symptoms was noted.

This report deals briefly with the cases of 8 Caucasian patients with glossopharyngeal neuralgia who were examined and treated by us within a period of five years. All recovered and were completely relieved by intracranial section of the ninth nerve and have had no recurrence of symptoms. There were 6 men and 2 women, the youngest 30 and the oldest 77 years of age. All had unilateral distribution of the pain, 5 having it on the left and 3 on the right.

In 3 patients with associated ear pain a few of the vagal fibers were also cut.

Glossopharyngeal (tic) neuralgia is a disabling disease which can be treated successfully by intracranial section of the glossopharyngeal nerve with no residual subjective symptoms.

INTRANASAL SURGERY OF THE MAXILLARY SINUS

HENRY M. GOODYEAR, M.D.

CINCINNATI

THE MAXILLARY sinuses are the most important of all the nasal sinuses. They are frequently infected, even in children, and with every infection of these sinuses there is always some extension of the infection to the ethmoid cells and often to the frontal sinus.

Thirty years ago it was commonly taught that the antrum was frequently infected by a downward flow of secretion from infected ethmoid cells or the frontal sinus, the antrum serving as a large cistern, catching the secretions from the sinuses above. It is now known that the reverse extension of infection is more apt to occur. If iodized oil is placed in the antrum and the patient's head is then lowered for even the matter of minutes, roentgenograms will show that the oil has migrated to the frontal sinus and ethmoid region.¹ This clearly indicates what may happen when a patient with an acutely infected antrum lies down. The infection must extend rapidly toward the ethmoid and frontal sinuses. Often the patient with an acutely infected antrum complains so bitterly of pain over the frontal sinus that the antrum may be overlooked, even though it is the primary source of infection.

Proetz,² Hilding³ and Tremble⁴ have admirably demonstrated the action of the cilia in the antrum about the mouth of the ostium in emptying and directing the flow of secretion away from this cavity. Thus, there is a strong argument for maintaining the antrum wall with its cilia in the region of the middle meatus. It particularly lends force to the condemnation of antrotomies done by way of the middle meatus.

An infected maxillary sinus is most frequently the cause of acute bronchial coughs which persist after what the patient thinks is a common

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Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society, 1949.

1 Goodyear, H. M. Use of Iodized Oil in Diagnosis of Nasal Sinus Conditions. Further Observations, *J. A. M. A.* **95** 1002 (Oct. 4) 1930.

2 Proetz, A. W. Essays on the Applied Physiology of the Nose, St. Louis, Annals Pub. Co., 1941.

3 Hilding, A. C. The Physiology of Drainage on Nasal Mucus. III. Experimental Work on the Accessory Sinuses, *Am. J. Physiol.* **100** 664 (May) 1932.

4 Tremble, G. E. Clinical Observations on the Movement of Nasal Cilia. An Experimental Study, *Laryngoscope* **58** 206 (March) 1948.

head cold It frequently is the source of a persistent afternoon or morning elevation of temperature in a child I have a patient who spent two years in a tuberculosis sanatorium for a constant cough Tubercle bacilli were not found The nose was clean, with a good breathing space There was no history that roentgenograms of the nasal sinuses had been taken After two years this young woman left the sanatorium of her own volition Roentgenograms with iodized oil showed an irregular filling defect in one antrum with some mild clouding of the ethmoid cells on that side A large opening was made under the inferior turbinate body, and six weeks later the patient stated that the cough had practically disappeared After eight years there has been no recurrence

INDICATION FOR SURGICAL INTERVENTION

If it has been determined that an infection of a maxillary sinus is chronic, surgical treatment is indicated Often the determination of a protracted low grade infection is greatly facilitated by the use of iodized oil as a contrast medium This is particularly true in the presence of corneal ulcers, infections of the uvular tract, persistent bronchial coughs without pulmonary changes, frequent or persistent colds in children as well as adults, mental depression and even behavior problems in children⁵

Chronic infection of the maxillary sinus in the presence of allergy adds to the difficulty of decision but does not contraindicate surgical intervention

CONSIDERATION IN THE CALDWELL-LUC OPERATION

If one determines to open and completely remove a thick infected cystic, hyperplastic membrane from the antrum, one must do it knowing that nature is not going to reproduce a new and normal membrane Frequently, repair is by a thick, fibrous membrane sparsely covered with cilia, and unless the opening under the inferior turbinate body is large and remains patent further trouble is usually imminent When only a large opening under the inferior turbinate body (antroscopy) has been done, a new membrane will also regenerate which may more nearly resemble the membrane of a normal antrum than that developed after a Caldwell-Luc operation and complete removal of the antrum membrane

When an antrum cavity, which has a normal surface area of some 35 to 50 sq cm, is completely denuded at one time one is asking a great deal of nature completely to cover this area with normal tissue Should there be such a denudation of skin in one area, one would surely consider grafting with skin

⁵ Goodyear, H M Nasal Sinuses Practical Considerations of General Interest *J Med* **13** 528 (Dec) 1932

In few cases it is necessary that the maxillary sinus be completely denuded. The success of a radical Caldwell-Luc operation depends not wholly on the complete removal of the membrane but more, as to the final result, on the size, shape and position of the opening under the inferior turbinate body and the care given the patient after operation. If a proper opening is made under the inferior turbinate body, a diseased membrane, which may completely fill the antrum, either recovers or a new membrane regenerates, as has been clearly demonstrated in cases completely filled with hyperplastic membrane recovering following antrostomy with removal of as little of the hyperplastic membrane as possible.⁶ It is the opening under the inferior turbinate that is important, not the opening in the canine fossa, nor the complete removal of the antrum membrane.

WHY DO ANTROTOMIES FAIL?

In 1943 a report was made of 100 cases from the New York Eye and Ear Hospital⁷ in which operation was done for maxillary sinus infection in 50 per cent the Caldwell-Luc operation and in 50 per cent intranasal antrotomy. The greatest number of failures followed antrostomy. The authors stated.

In a large number of cases we found the antrostomy opening quite small and located superiorly, just beneath the attachment of the inferior turbinate, usually quite well posteriorly, and in such a position the aperture certainly does not permit drainage or ventilation. Its purpose has then been defeated. We do not know the cause of our failures.

It is quite clear that the antrotomies were improperly performed, and very little or no relief would have possibly occurred in the chronically infected antrum. In order to succeed, there must be a very large permanent opening under the inferior turbinate for years (usually for life) after operation. Especially must the posterior portion of the opening be wide and well rounded.

The authors of this quotation are not to be criticized. They were following a procedure commonly taught in doing an antrotomy.

An antrotomy operation requires specific instruments and precise procedure throughout. Otherwise, it cannot succeed. One of the arguments for the Caldwell-Luc operation is that it gives a good exposure and a direct route of attack on the ethmoid cells. This is true, but in the performance of the operation the pars membranacea with its cilia is destroyed and the normal ostium of the antrum obliterated.

⁶ Goodyear, H. M. Chronic Antrum Infection. Treatment by Intranasal Antrum Operation and Packing, *Clinical and Experimental Results*, *Arch Otolaryng* 20: 542 (Oct.) 1934.

⁷ Stahl, R. H., Voorhees, D. R., and Davol, R. T. A Survey of Antral Surgery. Review of One Hundred Cases, *Laryngoscope* 53: 186 (March) 1943.

Again I wish to emphasize the importance of saving the membrane and middle meatal wall of the antrum. It is in this area that there is the greatest action of the cilia which prevent secretions coming from the region of the frontal sinus or the ethmoid cells from entering into the antrum.

If an infraorbital ethmoid cell is present, it usually appears on roentgenograms as a partition in the upper medial angle of the antrum. This compartment can be reached successfully through the antrotomy by means of a Pratt curet (fig 1). If the floor of this cell is removed it has had the best of treatment. It is argued that an opening under the inferior turbinate is always above the floor of the antrum which, however, does not seem too bad as to the end result. A small ridge in the lower



Fig 1—Use of the Pratt curet for approaching the naso-orbital angle of the maxillary sinus

border of the opening helps to keep secretions which are passing backward on the floor of the nose from entering the antrum.

HISTORY

Credit for first advocating approach to the maxillary antrum through the inferior meatus goes to J. Mikulicz,⁸ who described his antrotomy in 1886 and voiced his disapproval of Zuckerkandl's⁹ approach through the middle meatus.

8 Mikulicz, H. Zur operativen Behandlung des Empyems der Highmors-höhle, *Arch f klin Chir* 34 626, 1886-1887.

9 Zuckerkandl, E. Normale und pathologische Anatomie der Nasenhöhle und ihrer pneumatischen Anhänge, Vienna, W. Braumüller, 1893.

Mikulicz' method is of historical importance, but to Lathrop,¹⁰ of Boston, goes the credit for describing in the year 1897 a routine method of enlarging the Mikulicz opening. Unfortunately, in his technic Lathrop sacrificed a portion of the inferior turbinate body.

STEPS IN THE OPERATION

Anesthesia—A local anesthetic plus $1\frac{1}{2}$ grains (0.1 Gm) of pentobarbital sodium given orally thirty to forty minutes before operation, preceded by a subcutaneous injection of $\frac{1}{6}$ grain (10 mg) of morphine, combined with $\frac{1}{150}$ grain (0.4 mg) of scopolamine given one to one and a half hours before operation is sufficient.

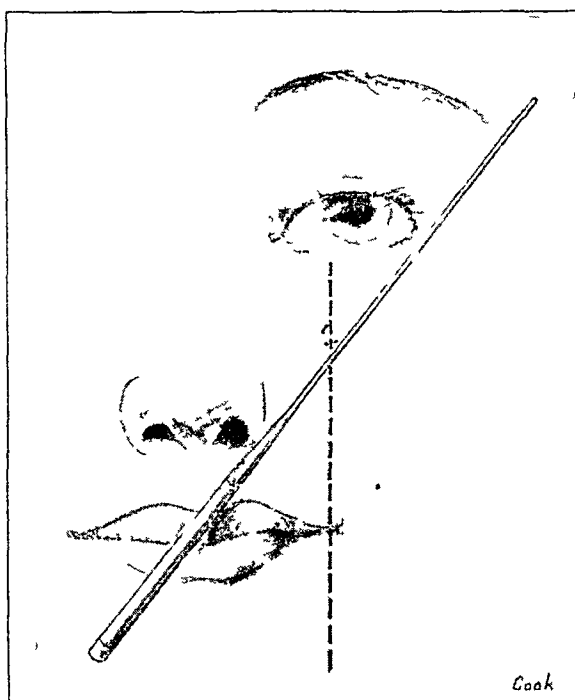


Fig 2—Line impressed on the cheek as aid in locating the infraorbital foramen

A 10 per cent solution of cocaine is applied in the nose to the region of the sphenopalatine ganglion and to the inferior and the middle meatus.

The local injection of 1 per cent procaine hydrochloride into the infraorbital foramen is carefully done in the following manner. After the cheek has been painted with a solution of tincture of merthiolate,[®] the locating of the foramen is facilitated by pressing a wire applicator firmly against the cheek from the nasolabial fold to the outer canthus of the eye. The injection is then made at the junction of this line (fig 2), impressed upon the cheek, and an imaginary line in the sagittal plane just medial to the angle of the mouth. Gentle palpation with the fingers may also help to locate the foramen.

¹⁰ Lathrop, H. A. Empyema of the Antrum of Highmore. A New Operation for the Cure of Obstinate Case, Boston M & S J **136** 455 (May) 1897.

An ordinary hypodermic needle ($\frac{5}{8}$ inch [1.6 cm]) is inserted into the foramen firmly to the hub, as advocated by Hill,¹¹ and 1 cc of the solution is injected slowly

Infiltration about the foramen will often give very good anesthesia after fifteen to thirty minutes, but injection directly into the foramen is much preferred

A few drops of procaine hydrochloride is now injected into the anterior area of the nasal septum on the side of operation to prevent unnecessary shock or discomfort of instruments being passed by this area. A small amount of procaine is also injected into the anterior lateral floor of the nose and the anterior attachment of the inferior turbinate body

The patient is permitted to rest for fifteen minutes between the local injection and the operation

Position of Patient—The sitting position (straight upright) is advantageous and the head, with the chin slightly lowered, should be held firmly by an assistant

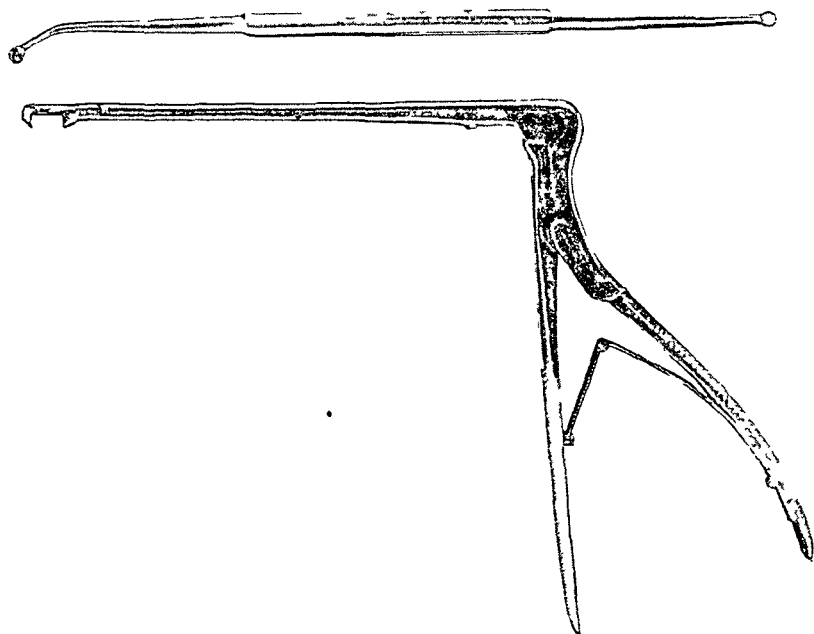


Fig 3—Above, Pratt's anterior ethmoid curet, below, heavy Hajek-Kofler downward biting sphenoid forceps

The stool of the operator should be somewhat higher than the usual working position. Many antrotomies are only partially successful because at operation the chin was not maintained in a lowered position and the operator was not sitting high enough to permit the proper application of the cutting forceps. These are important details for the steps which are to follow

Elevation of Inferior Turbinate Body—The inferior turbinate body is elevated by means of the curet end of a Dunning (Carter) submucous elevator placed firmly against the lower edge of the turbinate. Should undue injury occur to the inferior border, annoying synechias may result. If synechias should occur after operation, they should be cut and the turbinate again elevated for a period

11 Hill, F T. Local Anesthesia for Surgical Treatment of the Sinuses, Arch Otolaryng 127 197 (Feb) 1938

of two weeks, when healing has occurred, the turbinate may again be lowered to its normal position

Perforation—Perforation is made with a Bishop perforator and withdrawn with a slight rotation forward, producing sufficient opening for the next step in the operation

Opening Anteriorly—A Wagner tip on a universal handle is used to cut anteriorly upward and downward to round the anterior portion of the opening. If

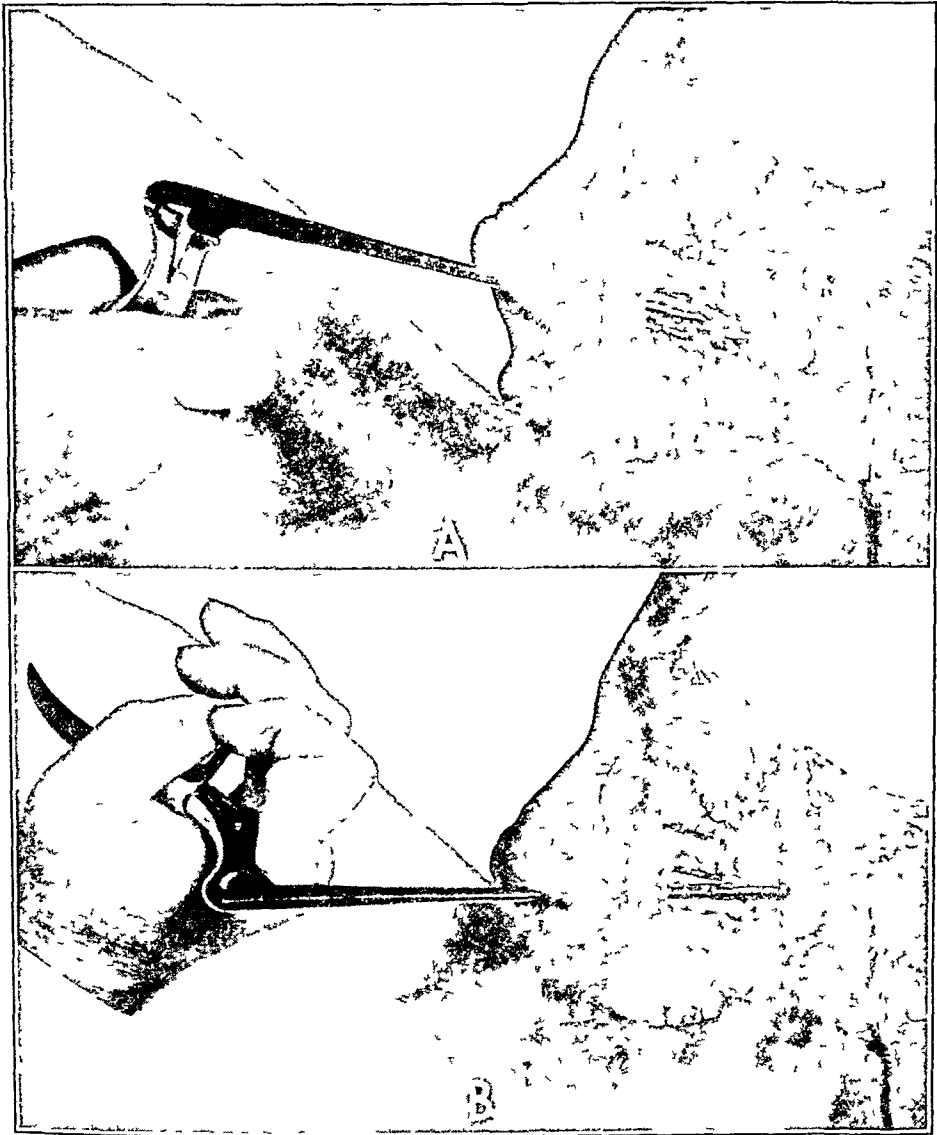


Fig 4—*A*, nose pushed well laterally and downward biting sphenoid forceps in proper position for cutting posteriorly and downward. *B*, position of hand and instrument with nose pushed firmly toward the opposite side in rounding the opening superiorly

the bone is unduly hard, a downward biting sphenoid forceps (Hajek-Kofler) may be used to increase the anterior opening

Opening Posteriorly—Here is where most failures in antrotomies occur. Of all the instruments particularly designed for this detail of the operation, none have been adequate

To determine the effect of various instruments for this procedure I used frozen heads, which were sawed in the sagittal plane in such a manner that the medial wall of the maxillary sinus was preserved and visible. The various instruments were then inserted through the nose and their action observed on the exposed wall of the sinus.

The most satisfactory opening was obtained by the use of a Hajek-Kofler heavy downward and through cutting sphenoid forceps¹² (fig 3). The tip of this instrument placed on a Universal handle proved unsatisfactory, as did also instruments with a weak or bending shank. Considerable pressure must be applied posteriorly, cutting as far posteriorly as possible and then downward (fig 4A) and upward (Fig 4B), to round out the posterior portion of the opening. The success of an antrotomy depends largely upon the precision and thoroughness exercised in making this portion of the opening.



Fig 5—Application of Pratt curet to floor of antrum

Injury to the descending palatine artery has not occurred experimentally or in practice, as the blunt rounded end of the sphenoid forceps protects this vessel. Experimentally a Gruenwald type of forceps will injure this vessel, and in all cases in which severe postoperative bleeding occurred I had used a Gruenwald forceps in extending the antrotomy posteriorly.

Should bleeding occur, packing the antrum and the antrotomy opening is effective. In only 1 of my cases was it necessary to open through the canine fossa to control the bleeding.

Opening Inferiorly—The sphenoid forceps used in the fourth step of the operation just described may be used to remove the bone toward the floor of the nose, but this edge of the opening can best be finished with the Yankauer downward biting antrum forceps.

¹² This forceps is produced by the Storz Instrument Company, St. Louis.

The five steps in performing an antrotomy are now completed (1) elevation of the inferior turbinate body, (2) perforation, (3) anterior cutting, (4) posterior cutting, and (5) inferior cutting. Each step is distinct and requires a different instrument, except that the sphenoid forceps may be extended, after making the posterior opening, over the lower edge of the antrotomy before finishing with the Yankauer tip on a universal handle.

Dealing with the Antrum Cavity—A Pratt curet (fig 3) is passed to the various angles and especially to the nasoantral angle (fig 1) where occasionally it will be necessary to remove the floor of an infraorbital ethmoid cell which may form a partition in this section of the antrum. Care is exercised not to destroy the pars membranacea as the middle meatus should remain intact.

Gentle curettage of the floor of the antrum (fig 5) may help to stimulate more rapid regeneration of a diseased membrane, but no attempt is made to denude the antrum cavity completely.

Packing—Firmly packing the entire maxillary cavity with a continuous strip of $\frac{1}{2}$ inch (1 cm) iodoform gauze controls bleeding that might occur immediately

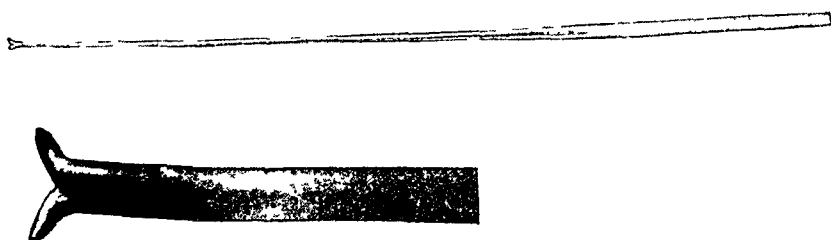


Fig 6—Applicator with split end for grasping gauze packing

after operation, and the pressure on a diseased cystic membrane seems to have a beneficial effect on the regeneration and healing of a diseased membrane. Robison¹³ has also come to this conclusion. For this reason it is well if the packing remains for four to seven days, or longer if the patient is comfortable. Packing is best accomplished with a straight bayonet forceps.

AFTER-CARE

Removal of Packing—I have seen surgeons struggle in an attempt to grasp the packing for removal with such instruments as a bayonet or nasal forceps. Often the nose is swollen and tender and the patient is apprehensive. Much discomfort may be avoided in this procedure by the use of a split end applicator (fig 6) rotated in the gauze packing after an application of a 10 per cent solution of cocaine. This instrument will also be found helpful in destroying a small polypus in the olfactory area or in removing cotton lost in the mouth of the sphenoid sinus.

After removal of the packing the patient is seen within a week or ten days, at which time a 5 per cent solution of cocaine is applied to the antrum cavity and the walls firmly palpated with a wire applicator carrying 2 to 5 per cent solution of silver nitrate on cotton. Should any cysts be present they usually rupture, as indicated by a straw-colored fluid.

¹³ Robison, J. M. Application of Local Pressure to the Mucosa of the Maxillary Sinus, *Tr Am Acad Ophth* 51:461 (May-June) 1947.

The applicator is also firmly pressed anteriorly and posteriorly in the antrotomy opening to discourage formation of adhesions

The patient should be seen at intervals until the antrum wall is smooth and secretion is not obtained on applying a dry cotton applicator to the floor

SUMMARY

An attempt has been made to show why many antrotomies fail and to stress in detail precisely each step required in a successful operation. It is not an operation to be considered lightly.

Most important, I have introduced not a new but a different instrument, a heavy (Hajek-Kofler) downward biting sphenoid forceps for making the most important—the posterior—part of the antrotomy opening. I have stressed the point of having this instrument on a permanent handle with a very stiff shank and of cutting the opening as far posteriorly as possible.

The importance of iodoform packing is emphasized not only for hemostasis but for the beneficial effect of pressure against a diseased hyperplastic membrane, stimulating more rapid regeneration of a new or healthy membrane.

The importance of retaining the pars membrana intact is distinctly emphasized.

I have described a helpful method of locating the infraorbital foramen and of grasping the packing for removal from the maxillary sinus.

✓ OZENA

Evaluation of the Surgical Treatment

MATTHEW S ERSNER, M D

AND

MAURICE H ALEXANDER, M D

PHILADELPHIA

EVER SINCE it has been possible to make a diagnosis of atrophic rhinitis with ozena, physicians have sought means whereby this disease may be combated, or at least a treatment which would allay the unpleasant signs and symptoms of the condition. These methods have been basically hygienic, but, except for creating a state of cleanliness, they have been unsatisfactory in control of the disease.

Atrophic rhinitis with ozena tends to attack more than one member of a family and is more prevalent in females than in males. It shows no predilection for Russian Jews or for heavy smokers but is prevalent in the Near East—in Latins and Orientals. Although it is also encountered in the Negroes of the United States, it is not seen in the African Negro.

Atrophic rhinitis with ozena is the end result of an inflammatory disease of the mucosal parenchyma of the nose and the lining of the accessory sinuses and begins in early childhood (fig 1).

Several postgraduate students from the Near East have informed us that atrophic rhinitis with ozena is one of the common diseases of their country. This may explain why an incense burner is a part of the household equipment of the Near East. Whether the incense combats the odor of the ozena or whether it is a part of the atmosphere of the Near East is debatable.

Through the years there have been many attempts at the medical and surgical treatment of this condition, either by stimulating the surface of the mucous membrane or by narrowing the nasal chambers.

Cauterization of the mucous membrane by use of chemical agents, such as silver nitrate, 5 to 20 per cent, or trichloroacetic acid, 1:2,000, has been tried. Cotton pledgets of McBride's solution,¹ iodides, potassium iodide and various other drugs were also used in attempts to cure this

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¹ McBride's solution has the following formula: iodine, 0.5 part, potassium iodide, 1.6 parts, glycerin, 30 parts.

malady, with little or no effect^{1a} Thyroid,² vitamins,³ estrogens⁴ and vaccines have had their trial and have been no more successful than efforts to determine the etiology of the disease It seems that the blood supply of the atrophied mucous membrane is insufficient to produce granulation faster than the denuding effects of the crusting

As far back as 1919 one of us (M S E)⁵ published an article on vaccine therapy of ozena

The bacteriologic characteristics of *Brucella foetida* (*Coccobacillus foetidus ozenae* Perez) were compared with those of *Escherichia bronchiseptica* and *Klebsiella pneumoniae* The *Br bronchiseptica* was studied by Perry, McGowan, Torrey and Rahe and was identified by them as being the specific cause of canine distemper and as being morphologically almost identical with, and in many instances biologically similar to, the Perez organism Burckhardt and Oppikofer placed the organism tentatively among the *Aerobacter aerogenes* group⁶ Horn placed it with the colon-typhoid bacilli

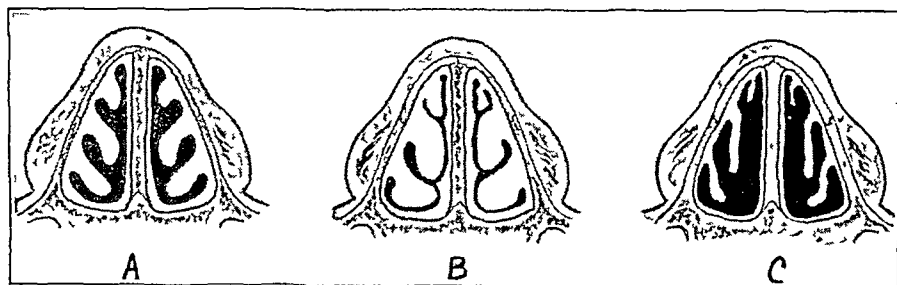


Fig 1—Schematic cross section of the intranasal chamber A, normal mucous membrane, B, hypertrophic mucous membrane, C atrophic mucous membrane, with increased space

Attempts have been made to inject paraffin in a semisolid state by stages under the mucous membrane or the mucoperichondrium of the septum and into the structures of the lateral nasal wall It was then

1a (a) Naftzger, J B Atrophic Rhinitis Ozena, *Ann West Med & Surg* **1** 18 (March) 1947 (b) Lederer, F Diseases of the Ear, Nose and Throat, Philadelphia, F A Davis Company, 1938

2 Cullom, M M Ozena, *J A M A* **117** 987 (Sept 20) 1941

3 Cody, C C Vitamin Therapy in Otolaryngology, *Arch Otolaryng* **41** 208 (March) 1945

4 Fitzhugh, W M, Jr Atrophic Rhinitis and Ozena, *Arch Otolaryng* **42** 404 (Nov-Dec) 1945

5 Ersner, M S Ozena Vaccinotherapy, Results of Serologic, Antigenic and Food Anaphylactic, *Laryngoscope* **29** 22 (Jan) 1919

6 Ersner,⁵ Thornell, W C Ozena Bacteriologic and Pathologic Studies, *Proc Staff Meet, Mayo Clin* **21** 90 (Feb 20) 1946

suggested that layers of ivory be inserted in an attempt to narrow the nasal passage. The foreign body reactions set up by this method sometimes produced, if they remained in situ at all, a condition as difficult to manage as the atrophic rhinitis. Beck took splinters of bone from the patient's ribs and inserted these, a few at a time, under the mucoperichondrium, the procedure depending on how rapidly the grafts took. This method seemed more logical in view of the improved circulation to the area if the bone graft should take. This procedure had the advantage that, in addition to narrowing of the air passage, the mucous membrane itself retained the power of regeneration. Eisenstodt⁷ suggested implantation of cartilage into the nasal septum beneath the mucoperichondrium bilaterally in an effort to narrow the air passage. He actually advocated narrowing the nares to cut down air flow.

More recently, Proud⁸ advocated insertion of acrylic transplants submucously between the mucous membrane and the nasal septum to narrow the nasal fossae.

Lautenschlager⁹ advocated the operation in which a buccogingival incision was made and the lateral nasal wall was separated along the floor of the nose, starting at the piriform sinus. The wall was then infracted to bring the turbinate bodies closer to the septum. The fragments of bone in the antrum were debrided, with the thought that the initial condition stemmed from chronic sinusitis. The lateral nasal walls were kept in contact with the septum until the bone healed.

Wittmaack¹⁰ modified the Lautenschlager operation by transplanting a buccal fold of mucous membrane, with the opening of the parotid duct, into the maxillary sinuses, thus, the parotid saliva constantly flowed over the walls of the sinus and entered the mouth through a permanent fistula in the buccogingival fold.

Halle¹⁰ further modified this operation into what he called the Halle-Lautenschlager method. As an exponent of the intranasal technic, he made no buccogingival incision, nor did he include a flap of the buccal mucous membrane or the parotid duct in the operation. His technic consisted in a chisel cut along the entire floor of the lateral nasal wall, which sets the nasal wall free from its attachments except at the superior border. The septum and turbinate bodies were then scarified, and the

⁷ Eisenstodt, L. W. Surgical Treatment of Atrophic Rhinitis, *Arch Otolaryng* **40** 45 (Dec) 1944

⁸ Proud, G. O. Acrylic Resin Implant for Atrophic Rhinitis (Preliminary Report), *Laryngoscope* **57** 256 (April) 1947

⁹ Lautenschläger, A. Operative Behandlung atrophischer Zustände des Nasennern, *Arch Laryng u Rhin* **31** 103, 1918

¹⁰ Kirschner, M., Lautenschlager, A., and Kleinschmidt, J. *Operative Surgery*, translated by I. S. Ravidin and G. M. Coates, Philadelphia: J. B. Lippincott Company, 1937, vol. 3

entire lateral nasal wall was infracted to bring the scarified surfaces together, they were kept in contact by packing the antrum with gauze until synechias were formed between the turbinate bodies and the septum

Hinsberg¹¹ reported a further modification in which light magnesium plates are fastened to the sial surface of the lateral nasal wall and, with fine magnesium wire, are held in place through the wall, the inferior turbinate body, the septum, the inferior turbinate body on the opposite side, the opposite lateral nasal wall and the second plate. These are then tied in order that pressure may be exerted toward the midline without the antrums having to be packed. The magnesium is resorbed or removed when the lateral nasal wall has been fixed toward the median line. Seifert,¹⁰ using only a suture, devised a similar operation without the magnesium plates.

During the course of performing several hundred rhinoplastic procedures in which the nose was narrowed with or without cancellous bone transplants on the dorsum, we noted that the patients with atrophic rhinitis and pronounced crusting showed specific improvement after the rhinoplasty wound had healed. The procedure of completing an osteotomy during a rhinoplasty had the specific effect of narrowing the air passage of the nasal chamber without distortion of its shape or relative proportions. In addition, when cancellous bone grafts were implanted into the dorsum of the nose, these grafts served to make the chamber narrower, improved circulation to the area and, at the same time, corrected the saddle nose deformity.

In the review of these cases, it was found that virtually all patients with atrophic rhinitis alone or atrophic rhinitis with ozena, particularly the latter, possessed to some degree a saddle deformity of the nose. This deformity, which appeared as a hook or hump, was usually a pseudo-hump rather than a true hump, because the deformity was caused by dissolution or absorption of the triangular and quadrilateral cartilages, such as it often seen after faulty submucous resection and contraction of the fibroconnective tissue. Thus, it would seem that the procedure should be of distinct benefit to patients with atrophic rhinitis and ozena, not only in narrowing the nasal passage sufficiently to produce relief of symptoms, but also in restoring the cosmetic effect of any concomitant nasal deformity. This operation was performed in 12 cases, with definite beneficial effect.

To perform this operation, one must be thoroughly acquainted with rhinoplastic procedure. The operation in itself does not pose any problems severer than those of any previously devised surgical procedure for ozena.

¹¹ Lederer, footnote 1a, part b. Kirschner and others¹⁰ Hinsberg, V. Operative Therapy for Ozena, *Monatsschr f Ohrenh* 55 1269, 1921.

In introducing the modified rhinoplastic operation for the treatment of ozena, measures are directed primarily toward the restoration of physiologic function and, at the same time, the production of a cosmetic improvement of the nose. In operation for cosmetic repair the hump is removed and a cancellous bone graft is inserted, thus, the patient has a straight dorsum with the physiologic improvement in the ozena.

TECHNIC

Our operative technic in the treatment of ozena is performed in one stage, providing the disease is not too far advanced.

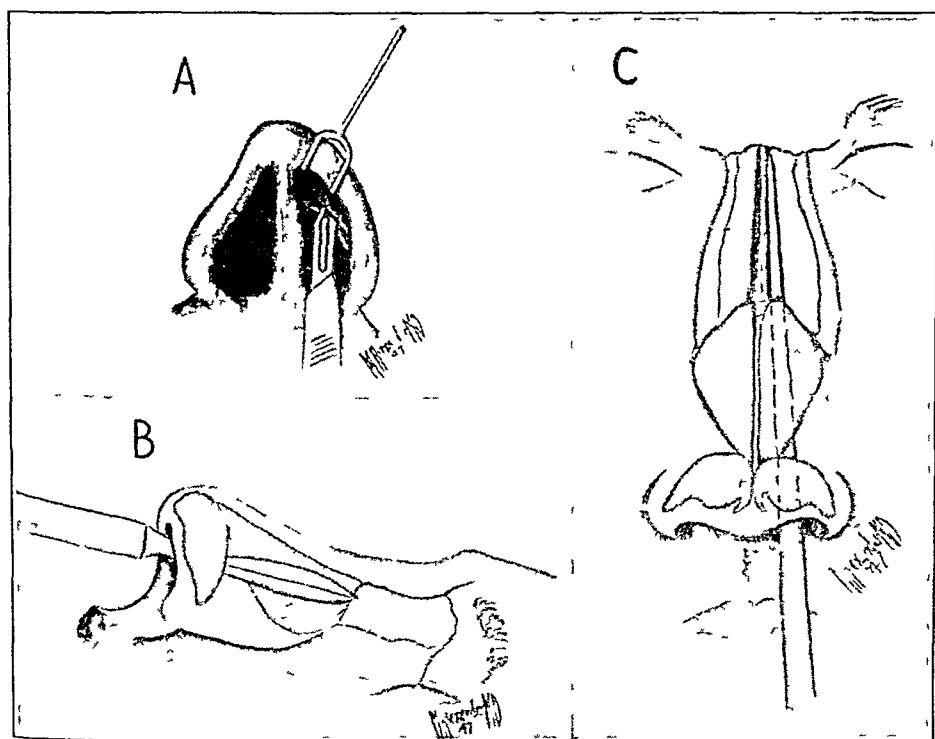


Fig 2—*A*, site of incision at caudal end of upper lateral cartilage, *B*, position of Fomon knife in freeing soft tissue over the dorsum of the nose, *C*, method of separating nasal bones from the perpendicular plate of the septum.

1 The patient is placed in a recumbent position, and the face, nasal vestibules and operative area are subjected to a thorough cleansing with soap, water, alcohol and ether, followed by a 1:1,000 colorless merthiolate® solution, a colorless mercury bichloride solution or a 1:1,000 solution of benzalkonium (zephiran®) chloride.

2 With regional block anesthesia produced with a 1 per cent procaine solution containing 1:30,000 epinephrine hydrochloride, the anterior palatine, the infra-trochlear, the ethmoidal and the infraorbital nerve, with its nasal branches, are anesthetized. It should be noted that in this operation the nasal mucous membrane is not anesthetized, so that the sensitivity of this membrane is retained as a safety measure.

3 With a Bard-Parker knife with a no 11 blade, an incision is made intranasally, slightly above the caudal border of the upper lateral cartilages within the nose (plica nasi) (fig 2 *A*) The incision is as deeply subcutaneous as possible As a precautionary measure, in making this intercartilaginous incision, one should be careful not to make more than one incision, otherwise, there will be unnecessary trauma and additional formation of scar tissue

4 With the double-edged Fomon knife, the incision is carried up over the ventral portion of the nose (dorsum nasi), to and barely beyond the distal border of the nasal bone (fig 2 *B*)

5 The same procedure is repeated on the opposite side of the nose

6 The periosteum is elevated from the nasal bones along the dorsum, and the nasal bones are then separated from the perpendicular plate of the ethmoid bone with a chisel and mallet in order to break the spring It must be borne in mind

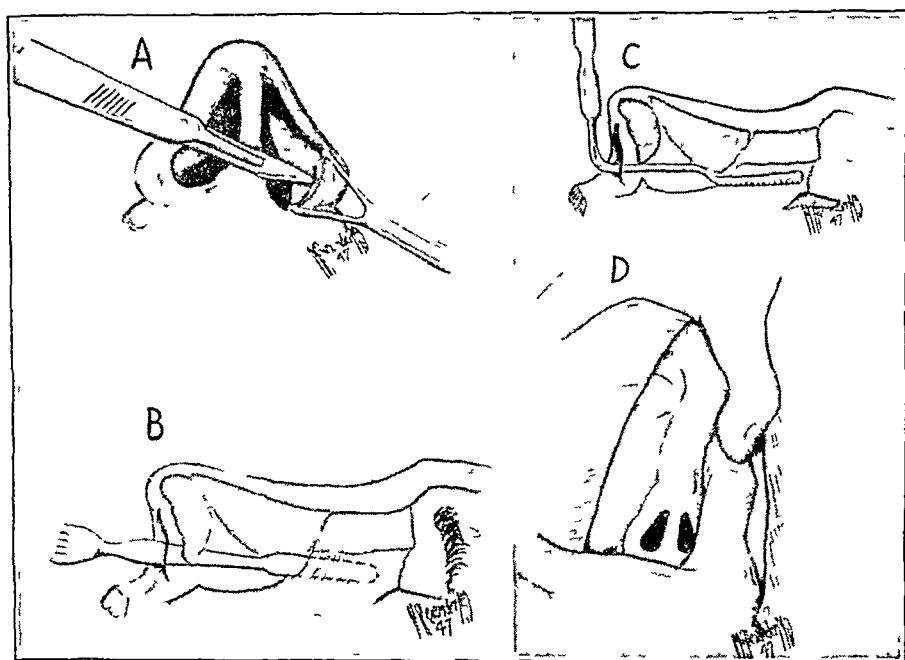


Fig 3—*A*, incision of piriform sinus for osteotomy, *B*, elevation of periosteum over the frontal process of the maxilla, *C* saw in situ for osteotomy, *D*, method of narrowing the nose by infraction

that with surgical procedures the blood circulation of the external and internal areas of the nose is greatly impaired Therefore, in separating the nasal bones from the septum, in order to break the spring so as to make it possible to narrow the nose after osteotomy, one should be careful not to disturb the periosteum unduly over the ventral portion of the nose (dorsum nasi) (fig 2 *C*)

7 Another incision is made in the inferior lateral portion of the anterior chamber of the nares exactly at the edge of the nasal process of the maxilla in the piriform process, the point of the scalpel should impinge on the anterior surface of the bone (fig 3 *A*)

8 With the Joseph type of periosteal elevator, the periosteum of the maxilla is elevated along the Gale (nasomalar) groove to the inner canthus of the eye on each side, and the bone is sawed partially through (fig 3 *B*) In

doing the osteotomy, one should be careful not to saw too deeply, and to avoid piercing the mucosa. Otherwise, one is apt to penetrate into the nose and damage the intranasal mucous membrane, which is already partially deprived of its circulation.

9 In creating the nasomaxillary groove, one should avoid cutting through completely, but should cut through sufficiently to create a groove in the frontal process of the maxilla so that a complete fracture will result, with complete immobilization and narrowing of the nose. A complete cut through the bone at this point might endanger the circulation of the mucous membrane by injury to the membrane, and it is for this reason that the inside of the nose is not anesthetized. Thus, if the saw were to penetrate at any point, the warning signal would be acute pain. Every caution should be taken to avoid a greenstick fracture, as such a fracture would result in incomplete narrowing. Both frontal processes are then fractured by application of thumb pressure medially (figs 3C and 3D). A definite snap is heard when the nose is completely fractured and narrowed. A low osteotomy of the frontal process of the maxilla is performed, so that the detached frontal process of the maxilla rests within the nose and close to the nasal septum. This procedure creates an actual narrowing and prevents synechia. When the frontal process of the maxilla rests within the nose, there is also less likelihood of any callus formation (fig 4).

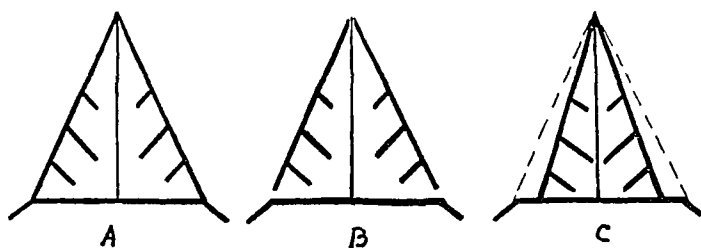


Fig 4—Schematic illustration of diminished space accomplished by osteotomy. A, nose before operation, B, nasal bones separated and frontal process of the maxilla cut, C, new position of the frontal process of the maxilla after osteotomy.

A change in the procedure was undertaken in several cases in which it was thought feasible to separate the upper lateral cartilages and to sew them over the ventral portion of the nose (*dorsum nasi*), instead of using the bony transplant to fill in the concavity. This modification helped also to narrow the nose and, at the same time, filled in the concavity.

In cases of mild atrophic rhinitis one may also narrow the ala of the nasal vestibule in a one stage operation. But, in cases of more advanced atrophic rhinitis it is best to perform a subsequent operation on the ala so as not to disturb the circulation too much at one time.

At this later stage, when the ala is narrowed so as further to reduce the size of the vestibule the volume and velocity of the air intake are therefore changed. A wide, roomy nose is not necessarily conducive to the proper volume of air intake or to proper distribution of the air. Normally, the nose is provided with upper and lower lateral cartilages, which act as valves, and the elliptic nares act as pressure slits, or chinks, through which the inspired air is forced and distributed. For this reason, wide nares, which are encountered in *ozena* are frequently narrowed in order to improve the synergistic action of these fluttering valves.

SUMMARY

A modified one stage rhinoplastic procedure for the improvement of atrophic rhinitis with ozena is introduced

The results of this operative method for the symptomatic improvement of the disease are evaluated

In a series of 12 patients, surgical procedures produced the following symptomatic relief

(a) Crustation was notably diminished after the rhinoplasty wound had healed

(b) There was restoration of physiologic respiratory function, and several patients noted improvement in their sense of smell

(c) With the low osteotomy, a narrowing of the nasal chamber was actually produced, this, in turn, helped to change the volume and the velocity of the air intake. We wish to emphasize that any defect in the technic of performing the osteotomy will defeat the purpose of the entire operation. Therefore, it is of utmost importance that a low osteotomy be performed in order that the narrowing of the nose be accomplished. Otherwise, the frontal process of the maxilla and the nasal bones will remain gabled, instead of narrowed, and will not be displaced toward the median line.

(d) Cancellous bone grafts implanted into the dorsum nasi (ventral portion of the nose) not only served to fill in the concavity but also helped to improve circulation to the nose.

(e) In addition to restoration of physiologic function, there was cosmetic improvement in the concomitant nasal deformity.

As a safety measure, the internal nasal mucous membrane is not anesthetized, the sensibility indicating the nearness of the approach of the saw to the mucous membrane in performing the osteotomy.

1915 Spruce Street (3)

TREATMENT OF ALLERGIC AND VASOMOTOR RHINITIS WITH HESPERIDIN CHALCONE SODIUM

BLAIR W SAYLOR, M D
TUCSON, ARIZ

THE DESIGNATION vitamin P was given in 1936 by Szent-Gyorgyi and his Hungarian co-workers to a substance or group of substances, other than ascorbic acid, which were present in extracts of paprika and lemon peel. The letter "P" was chosen because the preparation appeared to restore to normal abnormally increased permeability of capillaries¹. The crystalline extract obtained from lemons was termed "citrin". This extract was believed to contain two different flavone dyes, hesperidin and eriodictyol glucoside, and was said to decrease the number of hemorrhages in scorbutic guinea pigs and to prolong their survival time. Clinical application indicated that the increased capillary permeability associated with nonthrombopenic purpura and infections was corrected by oral administration². Early attempts³ to confirm the results obtained in animals were unsuccessful, but later several investigators were able to show that vitamin P does

From the Thomas-Davis Clinic

Ingram Laboratories Inc, San Francisco, supplied the material used in this study

Thesis approved by the faculty of the Graduate School of Medicine of the University of Pennsylvania in partial fulfillment of the requirements for the degree of Master of Medical Science [M Sc (Med)] for graduate work in otolaryngology

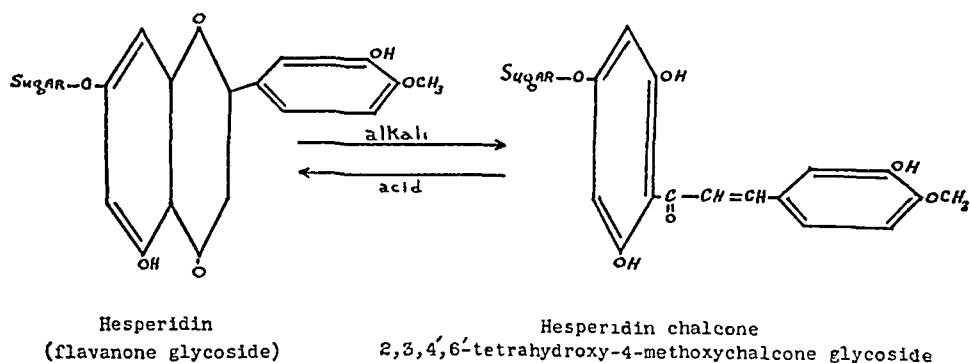
1 Armentano, L, Bentsáth, A, Beres, T, Ruszynak, S, and Szent-Gyorgyi, A. The Effect of Substances of the Flavone Group on Capillary Permeability Vitamin P, *Deutsche med Wchnschr* **62** 1325, 1936

2 Bruckner, V, and Szent-Gyorgyi, A. Chemical Nature of Citrin, *Nature*, London **138** 1057, 1936

3 Zilva, S S. Vitamin P, *Biochem, J* **31** 915, 1488, 1937. Moll, T. The Question of Vitamin P, *Klin Wchnschr* **16** 1653, 1937. Detrick, L E, Dunn, M S, McNamara, W L, and Hubbard, M E. Vitamin C Studies. I The Effect of Vitamin P (Citrin) on Vitamin C Deficient Guinea Pigs, *J Lab & Clin Med* **25** 684, 1940. Szent-Gyorgyi, A. Methods for the Preparation of Citrin, *Ztschr f physiol Chem* **255** 126, 1938. McHenry, E W, and Perry, H M. Observations on the Relation of Vitamin P to Scurvy, *J Nutrition (supp)* **19** 12, 1940

affect capillary resistance ⁴ It was found also that certain flavone dyes caused sudden decreases in blood pressure when administered intravenously, but that hesperidin and eriodictyol did not ⁵

Wawra and Webb,⁶ at the University of California Medical School, initially prepared citrin by a method similar to that of Szent-Gyorgyi, which consisted in extraction of ground lemon peel with acetone, precipitation with barium hydroxide and liberation of the pigment with sulfuric acid in a small volume of methyl alcohol On the preparation's standing for several days, a white precipitate of hesperidin slowly separated out, accompanied with bleaching of the solution This observation, along with others in the course of the work, led Wawra and Webb to regard the yellow eriodictyol of Szent-Gyorgyi as the chalcone of hesperidin This explains the difficulty encountered by Szent-Gyorgyi in separating hesperidin from the yellow material, inasmuch as there is an equilibrium between the flavonone and its open chalcone isomer (figure)



Structural formula showing equilibrium between the flavonone and its open chalcone isomer

The material used in this work is pev-gram,^{® 7} which is the sodium salt of hesperidin chalcone The chemical formula is di to tri sodium salt of 2',3,4',6'-tetrahydroxy-4-methoxychalcone-6-O-rhamnoglycoside The mechanism of the action of vitamin P is not entirely unknown, but much work has yet to be completed with proper testing for verification The mode of action as suggested by Lavollay is quite inter-

4 Zacho, C E The Influence of Ascorbic Acid and of Citrin on the Capillary Resistance of Guinea Pigs, *Acta path et microbiol Scandinav* **16** 144, 1939 Bacharach, A L, Coates, M E, and Middleton, T R A Biological Test for Vitamin P Activity, *Biochem J* **36** 407, 1942 Bourne, G H Vitamin P Deficiency in Guinea Pigs, *Nature, London* **152** 659, 1943

5 Armentano and others¹ Bruckner and Szent-Gyorgyi²

6 Wawra, C Z, and Webb, J L Isolation of New Oxidation-Reduction Enzyme from Lemon Peel (Vitamin P), *Science* **96** 302 (Sept 25) 1942

7 Pev-gram, registered trade name of Ingram Laboratories, Inc, San Francisco for hesperidin chalcone sodium

esting Vitamin P acts as an inhibitor of an oxidizing enzyme—amine oxidase—and thus inhibits the oxidation of epinephrine This action explains why favorable results are obtained in the treatment of vasomotor and allergic rhinitis, because epinephrine is a natural antagonist to histamine

The nose, besides constituting the natural airway for respiration, has three primary functions (1) It accommodates the olfactory organ, (2) it conditions the inspired air to the requirements of the pulmonary surfaces by warming, moistening and filtering it, and (3) it cleanses itself of the foreign material which it has extracted from the air This last-named function, completely overlooked by most authors, is at least as important as the rest for health and much more important than the rest in the control and eradication of infectious diseases and pollens Other attributes ascribed to the nose, such as vocal resonance, gas exchange and the regulation of air flow, are secondary and usually incidental ^{7a}

The term “allergy” was coined by von Pirquet to denote a state of altered reactivity on contact with foreign substances The term has been generally accepted as applying to all the forms of hypersensitivity in man, such as asthma, allergic rhinitis (hay fever), vasomotor rhinitis, eczema, urticaria and migraine By modern definition allergy is a state of exaggerated susceptibility to a foreign substance or physical agent that is harmless to the majority of people

Hay fever is an allergic nasal syndrome occurring seasonably and produced by hypersensitization to the pollen of plants when the pollen is in the air Vasomotor rhinitis is a constantly recurring or chronic and persistent form of nasal allergy, usually due to hypersensitization to inhalants, food, bacterial protein or to any combination of these Between acute attacks of hay fever, or allergic rhinitis, the nasal mucous membrane may often show this vasomotor type of reaction

The chief pathologic change in the nasal mucosa is edema The epithelium is edematous, with desquamation of cilia and cells and an increase in goblet cells, the basement membrane may be thin or thickened The changes in the tunica propria are most characteristic and consist in edema, which begins and is most pronounced in the subepithelial layer of the mucosa, while the deeper layers are less swollen In addition, there is eosinophilic infiltration, with increase of lymphocytes, plasma cells and fibroblasts When the connective tissue of the tunica propria can no longer support the weight of the edema, it prolapses as a mucous or edematous polyp Where the connective tissue is

^{7a} Proetz, A W Physiology of the Nose, in Jackson, C and Jackson, C L Diseases of the Nose, Throat, and Ear Philadelphia, W B Saunders Company 1945

firmer, as on the septum, the inferior turbinate bone and the medial surface of the middle turbinate bone, sessile masses, called polypoid hyperplasias, form⁸

The treatment of allergic and vasomotor conditions of the nasal passages has gone through numerous phases and changes during recent years. Many new remedies which are considered superior to older drugs are always appearing in the literature, but to date we physicians are still looking for more relief for our patients. The product pevg-gram[®] was used in the study presented here to determine its effectiveness in the relief of symptoms resulting from rhinitis of the allergic and vasomotor types. Ninety-nine patients were studied, and the work was continued over a period of approximately eighteen months. The ages ranged from 14 to 65 years. The conditions treated ranged from severe edematous allergic rhinitis, showing pronounced eosinophilia on examination of nasal smears, to mild nasal stuffiness, with no infection or eosinophilia on examination of nasal secretions.

Incidence of Relief from Symptoms with Use of Hesperidin Chalcone Sodium

Type of Rhinitis	Complete Relief	Partial Relief	No Relief	Side Reactions
Severe edematous allergic	0	6	16	2
Mild to moderate seasonal allergic	5	11	3	1
Vasomotor	28	17	6	2
Vasomotor, with associated migraine headache (histamine cephalalgia)	2	—	—	—
Total number of patients	35	34	25	5
Per cent	35	34	25	5

This group of patients lived on the desert in the Southwest at the time this study was made. However, many of them came from practically every part of the United States, with a few from Canada and Mexico. Due to the mild climate here, there are pollens in the air approximately ten months out of each year. For this reason the duration of the seasonal types of hay fever is greatly prolonged. Besides this, the always present house dust must be considered. The dust of the desert is practically inert, but it does cause a certain amount of irritation of the nasal mucous membrane, which, added to nasal sensitivity, aggravates the symptoms.

Another factor that causes trouble is the physical type of vasomotor rhinitis. This condition is due to extreme changes in climatic temperature. On the desert, the change in temperature is as much as 40 to 50 degrees daily. Most patients had trouble adjusting from the warm to

⁸ Morrison, W. W. *Diseases of the Nose, Throat and Ear*, Philadelphia, W. B. Saunders Company, 1938.

the cool air, but a few had just the opposite problem. The relative humidity, which is low on the desert, augments the physical reaction of the nasal mucosa. In the table is shown the response obtained with hesperidin chalcone sodium.

Thirty-five patients, or approximately 35 per cent, showed complete relief from symptoms. None of the patients with severe edematous rhinitis showing eosinophilia of the nasal secretions had complete relief from symptoms. Five patients with a pale-looking mucous membrane, associated with seasonal sneezing and nasal stuffiness, responded satisfactorily. Twenty-eight patients with a vasomotor type of nasal mucous membrane had complete relief from symptoms. Two patients with vasomotor rhinitis, associated with a migraine type of headache, experienced complete relief from the nasal symptoms and the headaches.

Thirty-four patients, or approximately 34 per cent, had partial relief from symptoms. Six patients with the severe edematous type of allergic rhinitis had partial relief from symptoms, but further therapy was necessary to obtain satisfactory relief. Eleven patients with the seasonal type of allergic rhinitis of a mild to moderate degree had partial relief from symptoms. Four of these 11 patients were sufficiently comfortable so that further study and therapy were unnecessary. The 7 remaining patients required additional study before sufficient relief was obtained. Seventeen patients with the vasomotor type of reaction had partial relief from symptoms. All but 2 of these patients obtained sufficient relief so that further therapy was limited to the use of mild nose drops for occasional nasal stuffiness. Twenty-five, or approximately 25 per cent, of the patients obtained no relief from the use of hesperidin chalcone sodium.

Sixteen patients had the severe edematous type of allergic rhinitis, 3 patients had mild to moderate seasonal allergic rhinitis, and 6 patients, the vasomotor type.

Side reactions were noted in 5 patients, or approximately 5 per cent. Two of these patients had the severe type of rhinitis—1, the mild to moderate type, and 2, the vasomotor type. Two patients had hives (urticaria) within twenty-four hours after the therapy was started. One patient with bronchial asthma experienced pronounced aggravation of the asthma, and the drug had to be discontinued. The 2 other patients experienced nausea without vomiting, which may or may not have been a direct result of the drug.

The use of hesperidin chalcone sodium had not eliminated or reduced the incidence of nasal surgery. The patients with nasal polyps required polypectomy. Patients with deviation of the nasal septum required submucous resection. When indicated, partial middle turbinectomy, formation of antral windows and similar nasal surgical procedures were done before relief from the use of the drug was experienced.

REPORT OF CASES

CASE 2—M S, a white woman aged 28, had severe seasonal hay fever due to fall ragweed at her home in Indiana. The remainder of the year she was fairly comfortable but always susceptible to infections of the upper respiratory tract. She had moved to Arizona in 1942 and had been comfortable and had no nasal troubles for two years. Nasal stuffiness with postnasal drainage occurred and became increasingly worse. Skin testing showed that the patient was moderately sensitive to bermuda grass, mesquite and dust. Examination of the nose showed an allergic type of mucous membrane during severe attacks and a vasomotor type of mucous membrane between acute flare-ups. Pev-gram® gave her the first real relief from the symptoms. It required 200 to 300 mg of hesperidin chalcone sodium daily to control them. After the symptoms subsided, 100 to 150 mg daily, in divided doses, was sufficient to maintain relief.

CASE 3—T M, a white woman, aged 35, complained of nasal stuffiness associated with deafness in the right ear. Examination revealed vasomotor rhinitis with moderate conduction deafness on the right side. Treatment with pev-gram® was started, 150 mg being administered daily, in divided doses. The nasal stuffiness subsided, but the conduction deafness persisted. Catheterization of the right eustachian tube on several occasions improved the loss of hearing. Later, while still continuing this therapy, the patient complained of nasal stuffiness. Examination revealed the airway to be large and widely open bilaterally. The therapy was changed, but she continued to complain of nasal stuffiness regardless of the fact that the examination usually revealed an adequate airway bilaterally.

CASE 42—S H, a white woman aged 24, complained of headache, stuffy nose, postnasal drainage and sneezing. Examination showed an allergic rhinitis not complicated with infection. Nasal smears showed an elevation in infiltration of eosinophils. Skin testing indicated a sensitivity to bermuda grass and rabbit bush. Besides this, she was decidedly allergic to eggs, which when eaten would cause an asthmatic attack to occur immediately. The patient was unable to eat away from home because of this extreme allergy to eggs. She was advised to avoid eggs completely, and treatment with hesperidin chalcone sodium was started, 400 mg were required daily, in divided doses, to relieve the symptoms. After they were relieved, the dose was gradually decreased until the patient was being maintained on 150 mg daily, in divided doses.

CASE 52—L L, a white woman aged 65, had had severe attacks of dizziness associated with nasal stuffiness, headache and nausea for the past ten years. These attacks were of such severity that she had to remain in bed for from twenty-four to seventy-two hours at a time. Her home had been in New York, where she had frequent infections of the upper respiratory tract. These infections always aggravated the attacks. Examination revealed vasomotor rhinitis with moderate conduction deafness bilaterally. The results of the examination otherwise indicated nothing abnormal. The patient was given 200 mg of hesperidin chalcone sodium daily, in divided doses. She has experienced only an occasional headache since the therapy was started and no attacks of dizziness sufficient to require her to be in bed. At present, she is taking 150 mg daily and has started to work again, which she had not done for several years because of this disability. This therapy left the deafness unchanged, and the patient is now planning to purchase a hearing aid.

CASE 69—H J, a white man aged 42, had symptoms of sudden dizziness which caused him to wreck his car. He would fall when walking, and one such attack resulted in lacerations of the face. There were no prodromal symptoms which

would indicate such violent dizziness, and accidents, therefore, could not be avoided. Examination showed vasomotor rhinitis. Results of examination of the ears, nose and throat were completely negative otherwise. The systolic blood pressure was 128, the diastolic, 84. The patient had been seen in Michigan for these same attacks and was given large doses of ammonium chloride orally, which gave partial relief for a relatively short time, but the severe attacks recurred even while this therapy was being used. The results of skin tests with histamine were positive. Desensitization with histamine diphosphate was not sufficient to control the attacks. Desensitization, together with the use of 200 mg of hesperidin chalcone sodium daily, in divided doses, gave complete relief from attacks. At present, he receives a maintenance dose of 100 mg daily, in divided doses, and has had no attacks for more than eight months. One mild attack which occurred was associated with too many cocktails the previous evening.

CASE 80—W R, a white man aged 40, came to me with a diagnosis of histamine cephalgia. His symptoms were severe headaches associated with nasal stuffiness and postnasal drainage, lasting for approximately six weeks and recurring two or three times yearly. Examination at the time of attacks showed a severe vasomotor rhinitis with considerable increase in mucus drainage. No pus was demonstrated, and roentgenograms of the sinuses indicated nothing abnormal. He has a septum-turbinate body adhesion on the right side, but this does not bother him except during attacks. These attacks completely incapacitate him. Desensitization with histamine gave only partial relief from symptoms. Treatment with hesperidin chalcone sodium, 200 mg administered in divided doses, was started in association with histamine desensitization, and the patient has had no debilitating attacks for more than fourteen months. At present, he receives a maintenance dose of 100 mg daily, in divided doses.

CASE 96—B S, a white man aged 33, complained of nasal stuffiness, sneezing and postnasal drainage. Examination showed vasomotor rhinitis. Skin testing showed a 4 plus allergy to bermuda grass. Several other products for oral administration were used to control the symptoms, but these products caused drowsiness, with dryness and itching of the nose. Treatment with pev-gram® was started. It required 200 to 250 mg daily, in divided doses, to control the nasal symptoms, but the side reactions of drowsiness, dryness and itching were not experienced.

The dosage of pev-gram® varied, depending on the severity of the symptoms. The average dose was 3 capsules, or 150 mg, daily, of hesperidin chalcone sodium. In all cases in which relief was experienced, a larger initial dose was required. This dose varied from 300 to 400 mg daily, over a period of from two to five days. As soon as relief from the symptoms occurred, the daily doses were gradually reduced, and a maintenance dose of 100 to 150 mg daily was sufficient to control the nasal symptoms. In the severe allergic cases which did not respond, daily doses of 400 to 600 mg were given. It was felt that greater amounts would not give relief, so the drug was discontinued.

The length of action of pev-gram® is approximately four to six hours, with recurrence of symptoms in about six to eight hours. When the drug is withdrawn, the symptoms reappear, except in those cases in which the offending material was removed or when the patient's allergic state had temporarily subsided.

SUMMARY

Hesperidin chalcone sodium has gained most of its popularity in maintaining normal capillary permeability and in correcting decreased capillary resistance. However, Lavollay has suggested that the action occurs because vitamin P is an inhibitor of an oxidizing enzyme—amine oxidase—and inhibits the oxidation of epinephrine. This explains why favorable results are obtained in the treatment of allergic and vasomotor rhinitis, because epinephrine is a natural antagonist to histamine.

Hesperidin chalcone sodium was used in the treatment of 99 patients with allergic and vasomotor rhinitis. Thirty-five per cent of the patients obtained complete relief from symptoms, 34 per cent obtained partial relief and 25 per cent experienced no relief. Five per cent of the patients showed side reactions: urticaria, aggravation of bronchial asthma and nausea without vomiting.

The amount of hesperidin chalcone sodium required for relief varied from 100 to 600 mg daily, in divided doses. The duration of action is over a period of four to six hours, and the symptoms reappear if the drug is withdrawn unless the offending factors are removed or the allergic state has passed.

The incidence of nasal surgery has not been affected by this therapy.

130 South Scott Street

MODIFIED TECHNIC OF PLASTIC PROCEDURE IN RADICAL MASTOIDECTOMY

Report of Results in a Case of Circumscribed Labyrinthitis and Periphlebitis of the Lateral Sinus in the Course of Chronic Purulent Otitis Media with Cholesteatoma

WALTER DWORETZKY, M D
NEW YORK

UNTIL the advent of such powerful antibiotics as penicillin, streptomycin and aureomycin, surgeons did not dare after a radical mastoidectomy to cover entirely with a plastic skin flap a labyrinthine fistula or periphlebitic bony defect of the lateral sinus, caused by active chronic purulent mastoiditis

In the case described here such a procedure combined with the use of antibiotics applied to both these lesions gave an excellent result and speeded healing

REPORT OF CASE

S S, a student at New York University aged 31, was first examined by me on Dec 16, 1948. He complained of recurring discharge from the right ear since early childhood and deafness on this side. For the last several months prior to the examination, spells of dizziness appeared, accompanied with nausea, especially on sudden and rapid movements.

Otосcopy of the right ear revealed a large granulation polyp in the bony part of the external meatus and a moderate amount of very foul purulent discharge containing white pearly flakes of cholesteatoma. The results of the Bezold test were positive. The left ear was normal.

Anterior rhinoscopy showed deviation of the septum to the right in its cartilagenous and bony parts, with subluxation into the left nostril. There was moderate secondary hypertrophy of the left lower turbinate bone. Both nasal cavities were obstructed, the right considerably more. Posterior rhinoscopy showed a slight enlargement of the posterior poles of the lower turbinate bodies. The pharynx was injected. In the right ear whisper was heard at the concha. The results of the Rinne test were negative. In the Weber test sound lateralized to the right.

In the accompanying audiogram are shown the results of the audiometric examination. The solid (preoperative) audiometric curve shows the average loss of air conduction hearing of the right ear for the frequencies in the speech range to have been about 65 decibels, with the loss for the 1024 frequency as low as 70 decibels, for high tones, the average loss was 85 decibels. The dotted curve expresses bone conduction hearing of the right ear. The broken line indicates air conduction hearing of the right ear seven weeks after the operation (February 21), showing an average improvement of about 10 decibels. The solid line (with x's) expresses air conduction of the left ear.

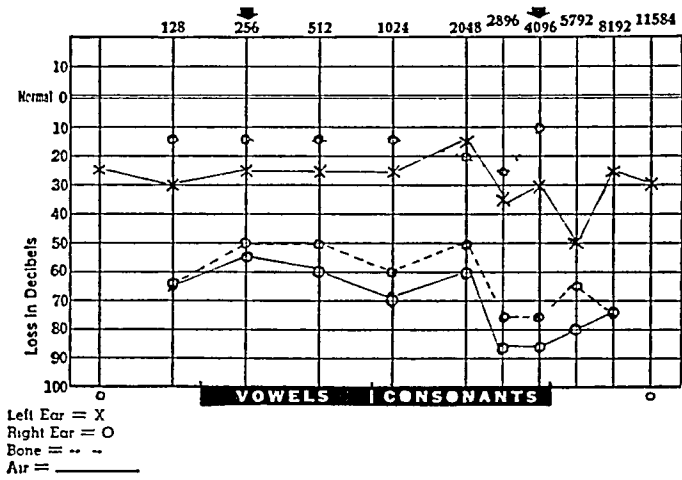


Fig 1—Audiogram made on Dec 17, 1948

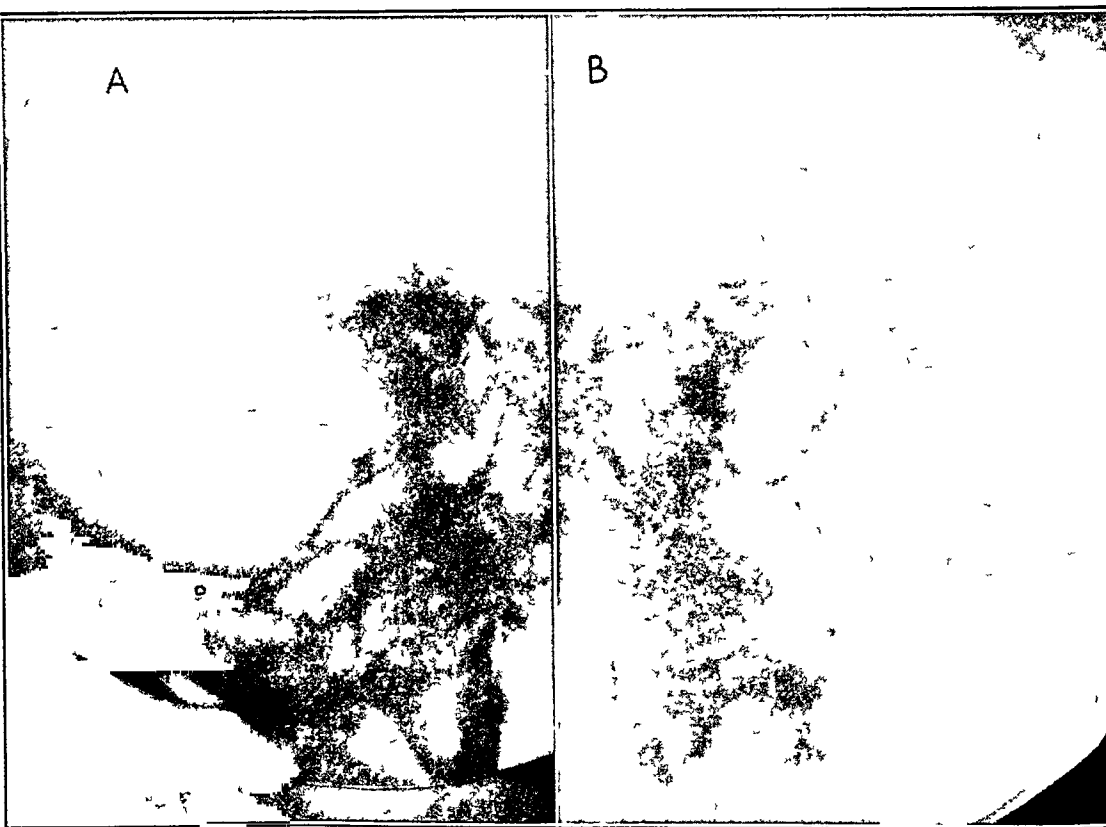


Fig 2—Roentgenograms showing (A) normal left mastoid and (B) sclerotic right mastoid

Spontaneous nystagmus of second degree to the left was noticed. The reaction to the fistula test was strongly positive. The tip of the index finger pushed against the outer meatus caused such a vigorous reaction that the patient had to be prevented from falling and a jerky nystagmus of third degree to the right persisted for about three minutes.

The roentgenographic examination of both mastoid processes was reported by Dr. Arthur Ettinger as follows: The left mastoid is normal. In the right mastoid the antrum is densely sclerotic, and there is an absence of cellular structure in the posterior portion of the mastoid. The roentgenographic characteristics indicate chronic mastoiditis on the right side.

A radical mastoidectomy by postauricular approach was performed on Jan. 4, 1949, with general anesthesia. The following conditions were encountered: The mastoid process was sclerotic, long and narrow and corresponded to the elongated skull of the patient. A few small periantral and perisinal cells and the tip cell

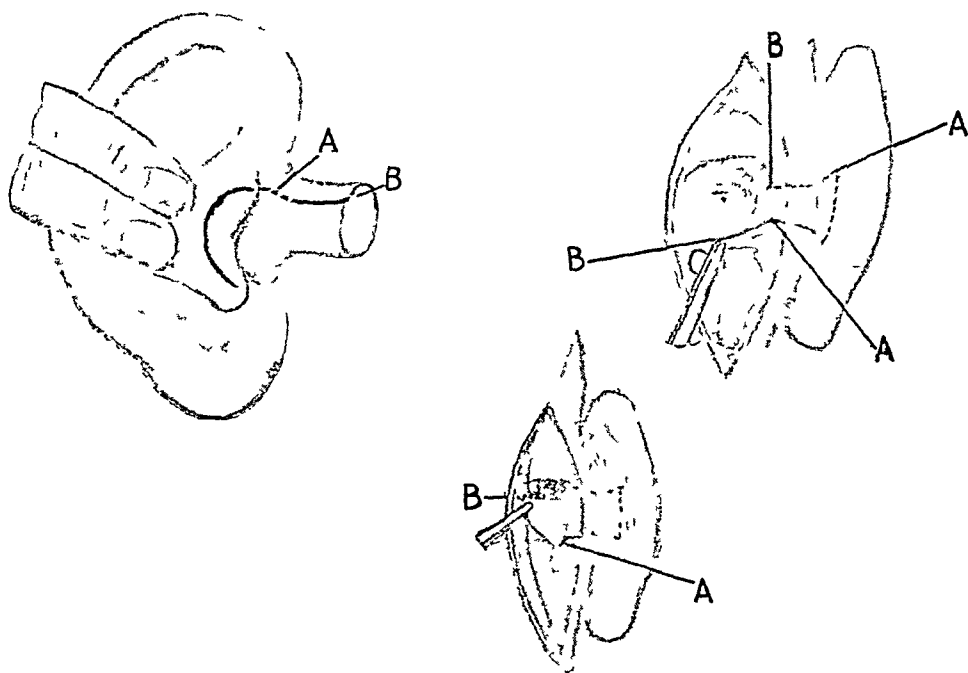


Fig. 3—Operative technic

were filled with pus and granulations. The antrum and the epitympanum were packed with cholesteatoma, the incus and malleus were missing. Beneath the dry inner surface of the matrix of the cholesteatoma, the mesial bony wall appeared polished. The prominence of the lateral semicircular canal was flattened, and a slitlike fistula without any granulations was evident in the canal. The lateral sinus was located too anteriorly—a quite common finding in a narrow mastoid process. The bony plate of the sinus was eroded, the erosion, of an irregular outline, was approximately the size of a dime. The sinus wall proper in this spot was discolored and thickened. The sinus was exposed around the defect in its bony plate beyond the area of the periphlebitic changes but was not punctured because the patient had none of the symptoms before the operation suggestive of obstructing thrombosis or thrombophlebitis (the temperature had been normal, and there had been no headache or chills, etc.). After the removal of the cholesteatoma and other pathologic tissues and the thorough eradication of all changed

cells, the radical mastoidectomy was completed, the tympanic cavity scrupulously cleaned, the bony part of the eustachian tube curetted and a modified plastic procedure performed

The plastic procedure is described in detail as follows

The success of the plastic procedure in radical mastoidectomy is appraised by a smooth, complete and durable epidermization of the whole wound inside and by a good cosmetic effect outside, behind the auricle, in the postauricular method

To reach this goal, the plastic operation was performed in a way which permitted diminishing the area for epidermization to the limit and fully utilizing the meatal skin for a flap. The conventional postauricular incision in its upper three fourths ran alongside and slightly behind the hair line and in the lower one fourth curved to the tip of the mastoid process. The meatal flap was formed by two incisions. The first, resembling Lempert's endaural incision, followed the edge of the auricular cartilage, with the starting point at the anterior-superior wall inward from the incisura anterior (fig 3, upper, left). The second (*AB*) incision was carried out from the same point at the right angle to the first one, straight mesialward to the inner end of the external canal (fig 3, upper, right). The angle *B* of the meatal flap thus formed by these incisions was stitched to the inner surface

Blood Counts

Date	Erythrocytes, No	Hemoglobin, per Cent	Leukocytes, No	Poly-morpho nuclears, per Cent	Lymphocytes, per Cent	Eosinophils, per Cent	Basophils, per Cent
1/6	4,310,000	84	21,200	70	27	3	
1/10	4,670,000	90	13,900	70	22	6	2
1/14	4,843,000	90	11,650	62	34	2	2
1/19	4,270,000	80	10,500	50	36	14	

of the posterior postauricular flap as far backward as possible from the latter's edge and above the level of the lateral semicircular canal. The meatal flap, somewhat overstretched, loosened considerably after the closure of the postauricular opening and thus was easily adjusted to cover entirely the labyrinthine fistula and the defect in the sinus (fig 3, lower illustration)

Such an arrangement of the plastic flap diminished considerably the area left for epidermization (above the meatal flap) and shortened greatly the healing period. The cavity below the flap, formed after the postauricular incision was sutured, readily filled with blood. Caution was exercised while the wound was dressed to avoid pressure on this slightly bulged area and thus promote healing by "the blood clot method." The inside dressing, consisting of several strips of petrolatum gauze, was packed tighter in order to insure the proper adherence of the meatal flap to the covered area.

The postoperative course was as follows. The day of the operation and the following day passed without any distressing symptoms, except for slight dizziness and nausea. Two days preoperatively and two weeks postoperatively, the patient was given sulfonamide drugs by mouth and 300,000 units of procaine penicillin in oil intramuscularly daily. From the morning of January 6 till the morning of January 12, the patient exhibited the signs of "destruction disharmony" (induced labyrinthitis) fits of dizziness accompanied with nausea, vomiting and strong spontaneous nystagmus of third degree to the left. The most frequent and severest fits occurred on January 8, 9 and 10, when the patient could hardly retain food

On January 9 the dressing was loosened inside, on January 12 the stitches were removed and the whole dressing changed. Until January 15 inclusive, the dressing was changed every day, and afterward, every second day. After January 13 the patient did not vomit, but during several days he still experienced dizziness and nausea from time to time. The lively spontaneous nystagmus of third degree to the left, which persisted from January 6 to January 12, changed into a slower nystagmus of second degree. All these symptoms gradually improved. The first three days after the operation the temperature did not exceed 101.6 F, and afterward it was below 100 F. The high leukocyte count (21,200) gradually dropped to normal. The urinalysis did not reveal any abnormalities.

On January 18 the patient was allowed to walk, at the beginning with the nurse's help. After January 19 all medications, including sedatives, were discontinued. On January 26 the patient was discharged from the hospital in good condition, with the wound almost healed. The wound was dressed every second day at my office, and after the seventh dressing, the postoperative care was considered finished. The epidermization of the operative cavity was complete. The

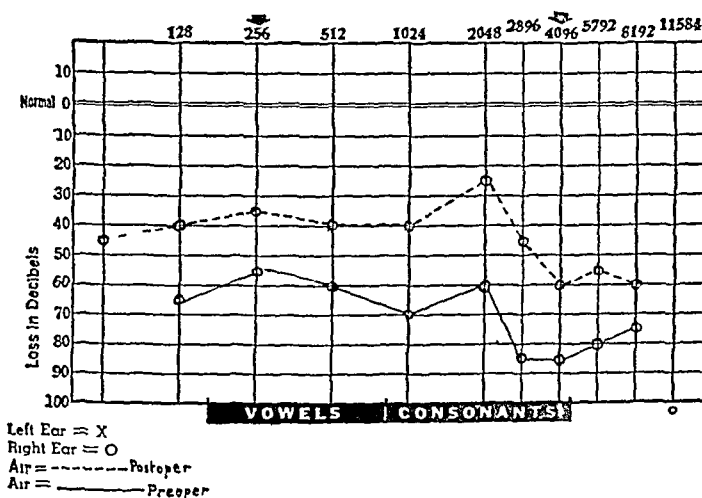


Fig 4—Audiogram made on March 17, 1949

cosmetic appearance of the postauricular area was excellent. Its shape did not differ from the contour of the side not operated on, and the scar was almost indistinguishable. On February 13, five weeks and three days after the operation, the patient, with my consent, attended his sister's wedding party, drank alcohol and danced till early in the morning without any ill effect.

The patient was presented on February 21 at the clinical conference of the Bronx Eye and Ear Infirmary. On March 17, ten weeks after the operation, the right ear was tested again, and the audiogram showed further considerable improvement (fig 4). The average improvement for the speech range was from 20 to 25 decibels, for 1024 frequency, 30 decibels, and for 2048 frequency, 35 decibels. Whisper was heard at 6 to 7 feet (1.8 to 2.1 meters).

SUMMARY

1 Operative procedure and postoperative care in a case of circumscribed labyrinthitis and periphlebitis of the lateral sinus, in the course of chronic purulent otitis media with cholesteatoma, are discussed.

2 The devised plastic technic made possible the covering of the labyrinthine fistula and the bony defect of the lateral sinus with the meatal flap and diminishing the area for epidermization

3 This modified plastic flap applied in combination with antibiotics considerably shortened postoperative healing and gave an excellent cosmetic result

4 In addition to these advantages of this plastic procedure, a noticeable improvement in hearing (from 20 to 35 decibels) was achieved. It remains to be seen whether this improvement will progress and be permanent. It is also too early to judge, ten weeks after the operation, whether the preexisting cholesteatoma will play some role in preventing osteogenesis in the fistula. For this reason the patient should remain under observation, and his hearing should be tested periodically during the next two years.

545 West End Avenue

Case Reports

SUPPURATIVE SIALADENITIS PRODUCED BY A FOREIGN BODY IN THE HYPOPHARYNX

Report of an Unusual Case

LIEUTENANT COLONEL NORMAN E KING
MEDICAL CORPS, UNITED STATES ARMY

The case to be reported is unique in my experience, and I am unable to find any such case to date reported in the literature. Furthermore, I am unable to explain the chain of events leading to involvement of the submaxillary glands. Whether the foreign body first entered Wharton's duct and then penetrated to the tonsillar fossa, or whether it entered the peritonsillar area, thus setting up an inflammatory process which dissected through to the gland, is a point of controversy. In view of the history of the case, the latter explanation is the more plausible.

REPORT OF CASE

A man aged 26, a lieutenant in the United States Army, was first seen at an overseas station in June 1945 with the complaint of a prickling sensation in the left tonsillar area. At this time nothing could be seen or felt on examination. A few weeks later he noticed a swelling in the left side of his neck, he experienced considerable difficulty in swallowing, and was unable to open his mouth more than 1 cm. He reported again to his battalion aid station in Germany, where he was given symptomatic treatment for one week, with subsidence of the swelling and pain and relief of the trismus. However, he still noticed a "hard lump" under the left side of the mandible in the region of the submaxillary gland. This lump remained stationary, without producing symptoms, until November, when there developed a simultaneous pronounced swelling under the left side of the mandible, pain in the throat and inability to swallow. The patient reported to a field hospital in Austria, where he was placed under treatment with heat, the symptoms and swelling gradually subsided within fifteen days.

In January 1946 he was admitted to an evacuation hospital with recurrence of the swelling under the mandible, pain on swallowing and some increase in temperature. At this time he was placed under treatment with penicillin and sulfadiazine, and his symptoms subsided within seventeen days.

During each hospitalization roentgenograms were taken, and at no time could calculi or an opaque foreign body be demonstrated.

On January 17, about three days after his discharge from the evacuation hospital, he was readmitted with a rather sudden recurrence of the symptoms and pain in the left ear. At this time a peritonsillar abscess was incised and a moderate amount of pus liberated. He was then placed under treatment with potassium iodide and penicillin, after which his symptoms rapidly subsided.

On February 3 he was returned to the Zone of the Interior for discharge. At the separation center, a physical examination revealed that the tonsils were moderately enlarged, that there was moderate injection of the soft palate on the left and that an old scar was present over the upper pole of the tonsil through which pus was exuding. There was a pedunculated granulating mass in the floor of the mouth on the left over Wharton's duct at its midportion. The left submaxillary gland was enlarged and hard, and pus could be expressed through the duct. Because of these findings, the patient was hospitalized for further treatment and disposition.

Roentgenograms of the gland showed no evidence of calculi. An injection of iodized oil U S P (Ipidol®) into Wharton's duct at this time showed a small amount of oil extending along a narrow tract posterior to the gland and pocketing in the soft tissues at the angle of the jaw. The gland itself was not outlined.

On March 26 a tonsillectomy was performed, and the small granulating mass on the floor of the mouth was removed for biopsy. The pathologic report was returned with a diagnosis of plasma cell granuloma. After removal of the mass, pressure on the gland caused pus to exude from the biopsy site.

The patient was then transferred to an Army general hospital, where the following notation was made: "At present, the left submaxillary gland is definitely enlarged, but it is neither tense nor tender. It feels somewhat cystic and does not appear to be involved in an active inflammatory process. The duct appears normal. There is no bulging into the floor of the mouth or evidence of any remnant of the granuloma which was previously removed. The left side of the soft palate is definitely edematous and intensely reddened. The site of the old incision made in January is still slightly apparent, although there is now no active drainage at this site."

On April 30 a second tonsillectomy was performed on the left side, and the following comment was made: "The left tonsillar fossa and faucial region were greatly indurated, with adhesions. There was a small amount of tonsillar tissue at the lower pole. The whole tonsillar fossa was opened, the tonsillar tissue was removed, and the adhesions were eradicated. When pressure was applied to the left submaxillary gland, secretion was seen to exude from the tonsillar fossa, indicating an apparent direct communication from the gland to the fossa." The pathologic report on the specimen follows: "The specimen consists of edematous granulation tissue, which contains a moderate number of histiocytes and a larger number of lymphocytes and is covered by fibrinous material. In the fibrinous layer is a large number of polymorphonuclear leukocytes and in some areas an accumulation of bacteria. Otherwise, no characteristic details are to be noted." The diagnosis was subacute inflammatory tissue.

The patient was then placed under treatment with penicillin, 30,000 units being administered every three hours intramuscularly, and received a total of 1,680,000 units.

During the entire postoperative course, pressure on the submaxillary gland produced drainage of creamy yellow pus from the middle of the left tonsillar fossa and from Wharton's duct. On April 26 a smear revealed rare pus cells. Hemolytic streptococci were isolated on culture.

The patient was transferred to the Oliver General Hospital in July 1946, and the following comment was made "The left submaxillary gland was moderately enlarged, hard and indurated throughout. There was no tenderness. Pressure over the gland caused expulsion of a few small clumps of pus from Wharton's duct, at the same time a small amount of yellowish material exuded from the left tonsillar fossa. The fossa was extremely scarred and fibrotic throughout."

The patient was placed under conservative therapy consisting of administration of penicillin, treatment with heat and daily massage for two weeks and was then given a convalescent leave of thirty days. He was seen again in September, with no change in the physical findings. The results of all laboratory tests were within normal limits. Injection of iodized oil U S P through the sinus opening in the left tonsillar fossa revealed a sinus tract contiguous with the left submaxillary gland and Wharton's duct. Injection of methylene blue through the same opening, after roentgenographic examination, revealed that the dye was expelled freely at the frenulum of the tongue, thus demonstrating a free and continuous communication.

Because of these findings and the patient's history of prolonged illness, a two stage surgical procedure was decided on in which the posterior sinus tract would be excised up to the submaxillary gland, this excision to be followed by extirpation of the gland and duct at a later date.

On October 28, with local anesthesia, a circular incision was made around the sinus tract in the left tonsillar fossa. With the guidance of a probe in the sinus, the dissection was continued laterally and downward to the anterior portion of the posterior belly of the digastric muscle. At this point a pocket, with an approximate diameter of 1 cm, was entered and from it a bristle, identical with an ordinary toothbrush bristle, was removed. The pocket was curetted thoroughly, and the tissues were closed tightly with 00 chromic sutures, without a drain.

The foreign body and the excised sinus tract were forwarded to the pathologist, who made the following report "Gross examination. Specimen A consists of a piece of apparently vegetable fibrin, measuring 1.5 cm in length and 0.2 cm in diameter. Specimen B consists of a piece of tissue of greenish blue discoloration, its surface covered with grayish yellow exudate. Microscopic study. The surface is covered with orderly stratified squamous epithelium of mucous membrane type. In one portion there is moderate acanthosis, but the basal layer is orderly in arrangement, and on one portion of the surface there is a small amount of keratohyaline material. In the underlying stroma there are numerous infiltrating plasma cells and lymphocytes. The sinus tract extends down into the granulating fibrous tissue, which in some areas is undergoing moderate hyalinization, while in others it is infiltrated with lymphocytic accumulations. Throughout the tissue are scattered, rather diffusely, well preserved erythrocytes, which are in areas occupied by adipose cells. At the bottom of the sinus tract, which is not lined with any epithelium, are portions of epithelial rests and salivary glands of mucous type. A few fibers of striated muscle, which are partially hyalinized, remain. The diagnosis is that of a sinus tract showing chronic granulation and inflammation from a foreign body (andropogen scoparius)."

The patient made an uneventful postoperative recovery and on the tenth postoperative day was given a second convalescent leave of thirty days. On his return, it was seen that the tonsillar fossa had healed completely and that the submaxillary gland had returned to its normal size and consistency. No pus could be expelled from Wharton's duct, and the patient was free from symptoms. He was discharged on December 31.

SUMMARY

A case is presented in which a foreign body, a toothbrush bristle, had apparently entered the left peritonsillar fossa and dissected laterally into the neck, setting up an inflammatory process which extended anteriorly to the submaxillary gland and duct and produced sialadenitis and a through and through sinus tract extending from the tonsillar fossa to the frenulum of the tongue.

HYPOPHARYNGEAL POLYP

DAVID W BREWER, M D
SYRACUSE, N Y

Polyps involving the hypopharynx are of sufficiently infrequent occurrence to make even a single case of interest

REPORT OF A CASE

A white woman aged 55 was first seen on Nov 30, 1948, with the chief complaint of intermittent episodes of nausea, associated with the feeling of a moving lump in the throat. This had been evident during the previous two years but had



Fig 1—Roentgenogram showing the mass in the esophagus. The polyp extended approximately 18 cm down the esophagus to just below the arch of the aorta.

become more noticeable during the past year, particularly during the two months prior to examination. Except for thyroidectomy performed eight years previously, the history was noncontributory.

On two occasions a long, thick, red object was regurgitated and hung out of the mouth down to the chin. The most recent occurrence was one week prior to her examination, at that time, on attempting to close her teeth on the object, she noted that it had the consistency of rubber.

Initial examination showed that the ears, nose and throat were normal. However, after a wait of approximately five minutes, a second indirect laryngoscopy revealed a small, rounded polypoid mass lying in the left piriform sinus. Roentgenographic examination with a barium swallow was performed on the same day. The roentgenologist, Dr. Clayton Hale, reported a smooth, elongated, sausage-like filling defect in the upper half of the esophagus (fig 1). This soft tissue mass apparently arose near the region of the cricopharyngeal muscle and extended down the esophagus for a distance of approximately 18 cm, or just below the arch of the aorta. There was no evidence of ulceration of any portion of the esophagus, and the mass was therefore considered to be a benign lesion. The hypopharynx and esophagus were otherwise not remarkable.

The next morning, direct laryngoscopy was performed, and approximately 15 cm of the polyp was teased upward, the mass was seen to be attached by a broad base to the left side of the hypopharynx on its posterior wall. Immediately after this, with the patient under anesthesia produced by intravenous injection of thiopental sodium U S P (pentothal sodium®) and with a Brown-Davis mouth

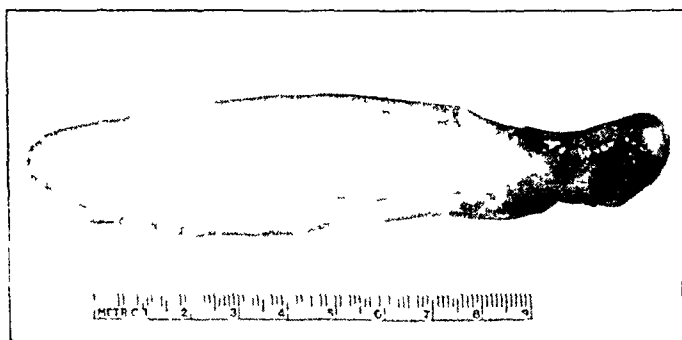


Fig 2—Appearance of the polyp after removal. It measured 13.5 cm in length and 3 cm in diameter in its midportion.

gag, a proximal portion of the polyp was visualized, grasped and teased upward and an 8 inch (20 cm) polyp was delivered through the mouth. A tenaculum, through a polyp snare, was placed on the distal end of the polyp, which was lying outside the mouth, and the polyp was removed with the snare. There was a small area of bleeding, 0.5 by 1 cm., in the lower portion of the piriform sinus on the left. Two plain 000 surgical gut sutures were used to approximate the edges of the bleeding area, and the bleeding was controlled entirely by this procedure. The postoperative course was uneventful, the nausea did not recur, and the patient has been asymptomatic since removal of the polyp.

The pathologic report described the polyp grossly as consisting of a huge, polypoid-appearing mass of very soft tissue. It measured 13.5 cm in length and 3 cm in diameter in its midportion (fig 2). It was 2 cm in diameter at the pedicle. Its surfaces were glistening, whitish pink and smooth in contour. A cross section revealed a fairly well defined outer margin with a very gelatinous, almost myxomatous, tissue in its central portion, which was glassy to whitish in color. The microscopic diagnosis was benign fibromatous polyp.

1100 East Genesee Street

Clinical Notes; New Instruments and Technics

LINEAR FENESTRATION OF LATERAL SEMICIRCULAR CANAL USING CURETS AND DENTAL EXCAVATORS

ERIC GUTTERIDGE, M D , F R C S (Edin), F R A C S
MELBOURNE, AUSTRALIA

The lateral semicircular canal is exposed and skeletalized to the posterior canal, where the curve has a direction directly medialward

The bony canal is curetted with a Lempert 0000 curet on the cranial, lateral and inferior aspects. With the largest Ash excavator the bony canal is removed down to the facial canal and forward to the vestibule. The blue line of the membranous canal is exposed from the superior canal and followed backward until it disappears from view toward the posterior canal. The excavator hollows the bony wall above and below the blue line. Further curettage removes the outer bony wall of the membranous canal. The excavator enters the canal and removes the overhanging edges until the maximum width is obtained. The smallest excavator has a diameter equal to that of the canal. Bone scrapings are wiped from the excavator and the field is flooded at intervals. The canal is followed to the vestibule and the superior canal may be exposed. The endosteum, presenting as a white lining of the bony fissure, is removed with the needle from behind forward and floated off by irrigation. The ampulla becomes visible, and the endosteum of the vestibule is removed.

It is believed that the bone debris produced by the dental drill is the cause of bone regeneration and closure of the fenestra. The dental excavators, moving away from the membranous canal, collect their scrapings on the disk of the tool, and the debris is wiped off between strokes. It is noteworthy that in the last year of operating, in which the dental drill has been discarded, the incidence of loss of improvement in hearing has become considerably reduced.

The photograph of a dissection of the medial wall of the antrum, attic and middle ear shows the extent of the canal fenestra from the vestibule to the posterior canal, the width obtained and the projection of the bony canal in the center of the fenestra (fig 1)

Complete removal of the white endosteum is essential, all shreds and streamers are lifted with the handled needle, assisted by gentle irrigation and scraped off against the bony edge of the fenestra. The completed window is of a red shade in its entirety, with, on occasions, the ampulla and membranous canal discernible.

The Ash excavators (fig 2) have blades 1, 2 and 3 mm in diameter, respectively. The angle of set of the blades aids in removing the hard bone quickly and permits of direct vision during their action. The blunt rounded edge cannot injure the endosteum and may be inserted into the canal to remove the overhanging rim. The elbow of the instrument permits of a direct approach to the canal being made.

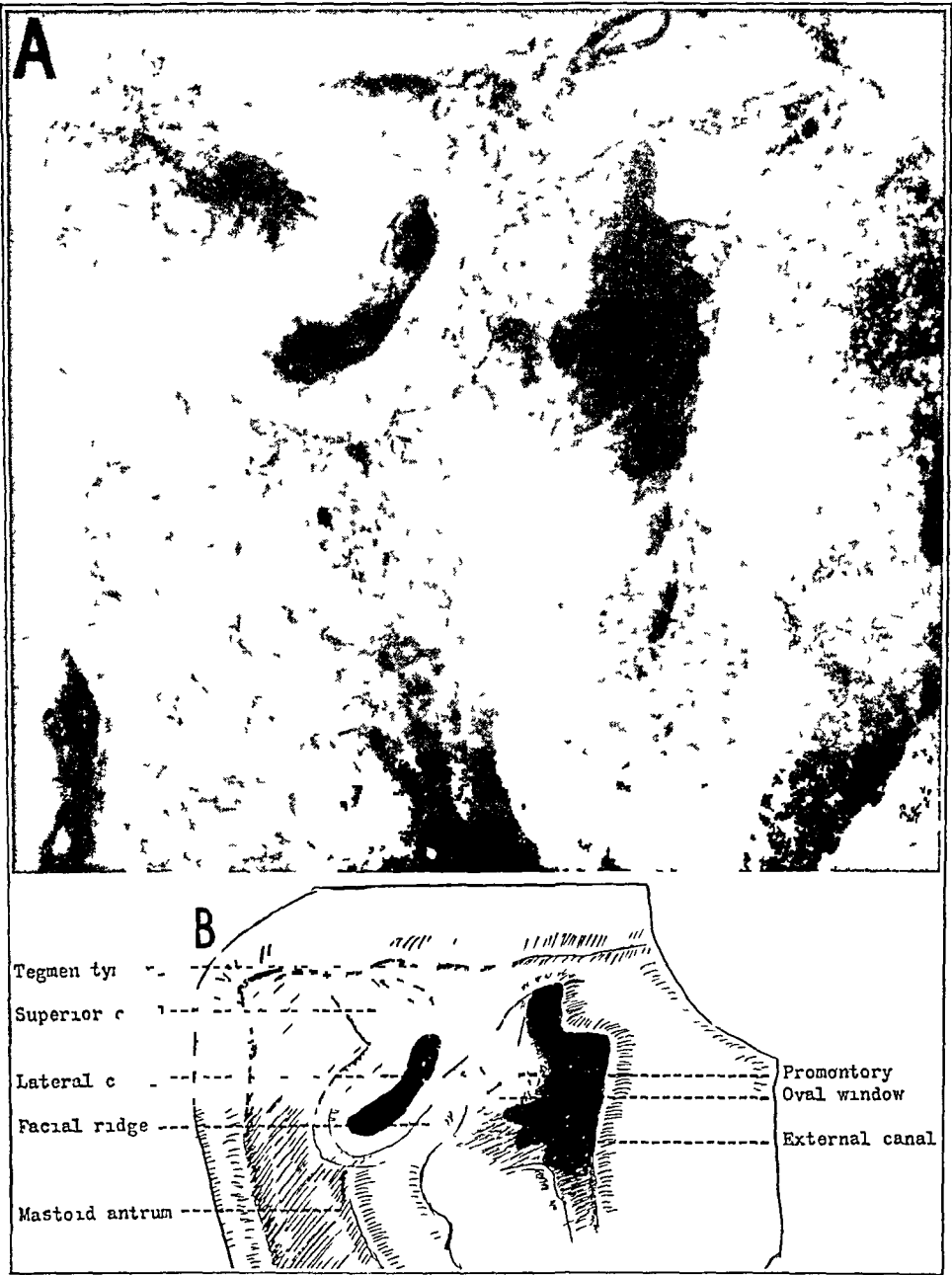


Fig 1—A, fenestration of the lateral semicircular canal B, diagrammatic key

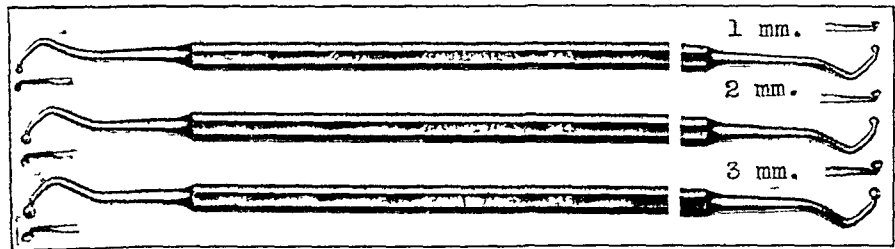
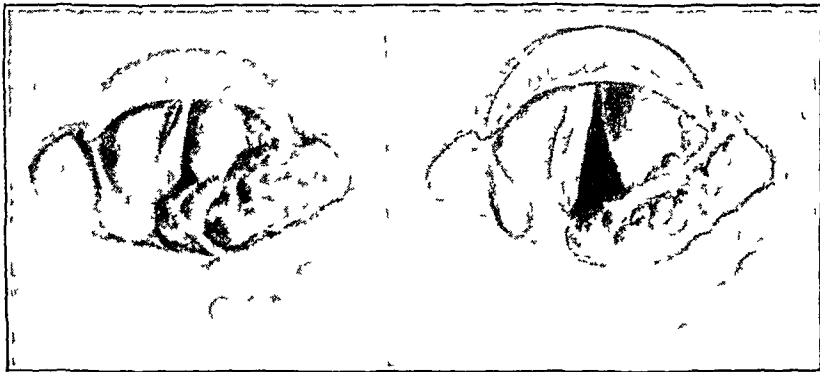


Fig 2—Set of three Ash excavators, with 1, 2 and 3 mm blades

HEMANGIOMA OF THE LARYNX

H BERNHARDT, M D
TEL-AVIV, ISRAEL

Recently I found among some of the material which I had brought with me from Germany the two accompanying pictures from a case of hemangioma of the larynx, which, so far as I am aware, is quite unique



Hemangioma of the larynx

A laborer, aged 35, was referred to me by a general practitioner for relief from severe attacks of suffocation. Examination revealed laryngeal hemangiomas of such size that they could completely obstruct the airway when they were swollen. On the advice of Professor von Eicken, I injected a few drops of 1:1,000 mercury bichloride solution. The effect was rapid. The hemangiomas disappeared completely, and so far as I know there was no recurrence. The patient did not return for further treatment, and he was soon lost to follow-up.

Abstracts from Current Literature

Ear

DEGENERATION AND NECROSIS OF NEURONES IN EIGHTH CRANIAL NUCLEI CAUSED BY STREPTOMYCIN LEWIS D STEVENSON, ELLSWORTH C ALVORD JR and JAMES W CORRELL, *Proc Soc Exper Biol & Med* **65** 86 (May) 1947

Neuropathologic study was made on 5 patients with tuberculosis who had acquired partial or complete deafness while receiving large amounts of streptomycin. Changes were present in the neurons of the ventral cochlear nuclei in all of them. Streptomycin in comparable dosage was administered to 3 dogs, which showed ataxia, tail chasing, weaving of the head and weakness, but disturbance in auditory acuity could not be demonstrated. Liquefaction necrosis was found bilaterally in the ventral cochlear nuclei hence the changes would seem to account for the deafness and vestibular dysfunction in clinical cases.

HANSEN, Galveston, Texas [*Am J Dis Child*]

LATENT OTITIS MEDIA IN INFANTS JEAN DESCAZEUX, *Rev de laryng* **67** 489 (Sept) 1947

Otitis media still is often not diagnosed in time in the presence of gastrointestinal cholera-like toxicosis resulting from otitic infection. Paracentesis of the drum is performed too late and too seldom in infants.

The diagnosis is frequently not easy. The infant's drum is much more horizontal than the adult's, the pars flaccida is pinkish and occupies a much larger portion of the drum, the short process of the malleus is extremely prominent, and the hammer handle is poorly seen because of the obliquity of the drum. Dulness of the drum with whitish or yellowish discoloration, absence of the cone of light and, sometimes, a "frosted" appearance indicate otitis media. The otoscopic examination should be repeated after several hours to observe the changes in the drum, the paracentesis should include the pars flaccida, if necessary, one should aspirate with Siegle's speculum. Often paracentesis should be bilateral. If no improvement in the symptoms occurs in forty-eight hours, antrotomy is indicated. The author states that he is against the diagnostic puncture of the antrum. Twenty-one cases recorded since 1945 are reported.

HERSON, Chicago

AURAL DISEASES OF INFANTS E GYORGY, *Paediat danub* **2** 160 (Aug-Sept.) 1947

In the first part of the article several aural diseases of infants, as catarrh of the tube and of the mucous membrane of the tympanic cavity, are discussed. Their symptoms can be divided into otologic (local) and pediatric (general) ones. Methods of medical and the eventual surgical treatment of each condition are dealt with separately.

Otitis is a common disease in the newborn. Its frequency amounts, according to statistical data, to 5 per cent. Its symptoms are enumerated in detail and the author underlines the significance of the sequelae such conditions may have.

Otitis of infants with desquamative erythroderma (Leiner's disease) is dealt with extensively. Differentiation of this condition is necessary as, because of the increased sensitivity and secretion of the skin of the external auditory canal and

of the epidermis of the drum, its pathogenesis varies from that of common otitis. In addition to this, the resistance of such patients is always decreased.

In the last paragraph, symptoms of initial otitis and mastoiditis are enumerated according to their pathogenetic and physiologic aspects. Then propagation of the infection from the tympanic cavity to the cells of the mastoidal process and the pathologic changes of purulent mastoiditis are discussed.

FROM THE AUTHOR'S SUMMARY [Am J Dis Child]

ROENTGENOLOGIC DIAGNOSIS OF MASTOIDITIS IN INFANTS AND CHILDREN P SON-NAUER, Paediat danub 2 147 (Aug-Sept) 1947

Three roentgenologic methods are in use in pediatric otology, those of Schüller, Stenvers and Mayer. By their aid it is possible to gather information about the condition of the pneumatic system, the extent of pathologic processes and the site of both the sigmoid sinus and the tegmen. Density of the mastoid cells and destruction of those of the pneumatic system are invariably present with inflammation.

For comparison, bilateral roentgenograms should be made in every instance—every second or third day in acute processes and once a week when the condition is chronic.

In infants, the procedures of Schuller or Mayer are to be used because that of Stenvers presents insurmountable technical difficulties. According to the author's experience, it is possible to gage the density of the antrums in quite young infants, while in those older than 6 months of age even mastoiditis can be seen, as at this age mastoidal cells already show distinct outlines.

FROM THE AUTHOR'S SUMMARY [Am J Dis Child]

THE SURGICAL PROBLEM IN OTOSCLEROSIS MAURICE SOURDILLE, Rev de larynx 68 481 (Oct) 1947

The author traces the history of the fenestration operation. Holmgren first employed the Gullstrand loupe and the binocular microscope and used radical mastoidectomy, the author himself used partial radical mastoidectomy, Ledoux (1933) used subcutaneous atticotomy, or simple resection of the roof of the auditory canal and the outer wall of the aditus. The latter procedure was later improved by De Lima and Aubry in France.

The author has continued to use the postauricular incision 3 cm behind the groove, this location of the incision tends to prevent subsequent stenosis of the external canal, which occurs more easily when the incision is made directly in the postauricular groove. After elevation of the skin and the periosteum and performance of a partial radical mastoidectomy with careful removal of the mastoid cells, he performs a tight closure of the tympanic cavity and the attic with a membranous-periosteal flap hinged at the tympanic membrane, this is the same technic used by the author in 1929. To fill the bottom of the mastoidectomy wound, the author uses additional posterior superior and posterior inferior fibromuscular grafts.

HERSON, Chicago

Pharynx

INFECTION OF THE NECK AFTER TONSILLECTOMY CLIFFORD F LAKE, Minnesota Med 30 851 (Aug) 1947

Infection of the neck after tonsillectomy is not a common occurrence but it does take place, and the author warns that after every tonsillectomy it should be watched for. The situation may be represented by cervical adenitis, cellulitis of

the neck, infection of a fascial space, thrombophlebitis and septicemia or any combination of these conditions. Some of these infections are dangerous and demand prompt rational treatment. In the paper such treatment is given in detail, and in the conclusion the statement is made that tonsillectomy should not be carried out in the presence of acute infection in the pharynx or mouth.

STOESSER, Minneapolis [Am J Dis Child]

Larynx

FOREIGN BODIES IN THE RESPIRATORY TRACT JOHN R RICHARDSON, New England J Med **235** 707 (Nov 14) 1946

The diagnosis of a foreign body in the respiratory tract is easy when one remembers to think of the possibility. The story of the patient or that of the patient's family should be believed until proved wrong. Roentgenologic examination should include the entire respiratory and digestive tracts. Fluoroscopy of the chest is indicated when a nonradiopaque foreign body is suspected. Unless a foreign body can be completely visualized, it is dangerous for one to attempt its extraction. The safe removal of a foreign body is aided by reference to a duplicate, as well as roentgenologic study, so that its exact position and location are understood. Only then can removal be accomplished without the possibility of doing more harm than good through unwise manipulation.

FROM THE AUTHOR'S SUMMARY [Am J Dis Child]

ELECTIVE TRACHEOTOMY FOLLOWING THYROIDECTOMY BERNARD J FICARRA, New York State J Med **48** 919 (April 15) 1948

This case report is from the Department of Surgery, St Peter's Hospital, Brooklyn. A man of 56 had hoarseness and dyspnea on exertion for several weeks, associated with a thyroid gland "twelve times normal size." Total thyroidectomy was done, plus an "elective tracheotomy." The tube was removed on the second day, and recovery was uneventful. Compression of the recurrent nerves is common in such cases, edema of the larynx or trachea is the indication for tracheotomy. The hazards of tracheotomy are infection of the wound, emphysema and pulmonary infection. Therefore, penicillin (20,000 units in 1 cc of isotonic sodium chloride solution five times daily) should be given while the tube is in situ. The best way to prevent emphysema is to pack the wound wide open. Against pulmonary infection, frequent suction and instillation of penicillin through the tube are helpful measures. Prior to removal of the tube, a roentgenogram of the chest should be taken, it may show fluid or an old blood clot. A friction rub similar to a pericardial rub may help to reveal the clot. Tolerance of a stylet in the tube for twelve hours indicates extubation. Three days is the longest time the tube is required.

VOORHEES, New York

Miscellaneous

THE TREATMENT OF MENINGITIS DUE TO HAEMOPHILUS INFLUENZAE WITH STREPTOMYCIN LOUIS WEINSTEIN, New England J Med **235** 101 (July 25) 1946

Nine patients with purulent meningitis, due to type B Hemophilus influenzae in 7 and to an untypable strain in 2, were treated with streptomycin, with complete recovery in 7 cases. The drug was given intramuscularly in doses ranging from 15,000 to 125,000 units every three hours and intrathecally in amounts varying

from 10,000 to 25,000 units every twenty-four hours. Two of the 9 patients with influenzal meningitis treated with streptomycin died. One showed complete absence of response to the antibiotic agent. The other died of an intercurrent bronchopneumonia due to *Staphylococcus aureus*, which was not affected by penicillin.

The blood and spinal fluid were cleared of the causative organisms in from twenty-four to forty-eight hours in all cases except the 2 due to atypical strains. No relapses or sequelae of the influenzal meningitis were observed in any of the recovered patients over a period of from six to ten weeks after the cessation of streptomycin treatment. No toxic reactions attributable to streptomycin were observed in the nervous, hematopoietic or urinary systems.

Infection with *Staph aureus* developed in 2 of the patients receiving streptomycin—meningitis in 1 patient and bronchopneumonia in the other—after they had been completely free of *H influenzae* in both the spinal fluid and blood for several days and were apparently recovering clinically. Bacteremia was present in both.

FROM THE AUTHOR'S SUMMARY [Am J Dis Child]

FULMINATING MENINGITIS AND INTRATHECAL PENICILLIN BYRON D ST JOHN,
New York State J Med 47 2603 (Dec 1) 1947

A white woman of 23 became violently ill and went quickly into coma, having had symptoms of an ordinary cold. On admission to the hospital, the patient had been ill only about five hours. Spinal puncture showed a pressure of 44 mm of mercury, there were 13,700 white blood cells, mostly polymorphonuclear leukocytes, per cubic millimeter. No organisms were reported in the smear or the culture. One hundred thousand units of penicillin in 5 cc of spinal fluid were injected slowly into the spinal canal, requiring forty-five minutes. A violent reaction of the unconscious patient made restraint necessary. Five grams of sulfadiazine sodium were given intravenously at once and 2 Gm of sulfadiazine through an intranasal tube every four hours. The blood culture remained negative, and there were no organisms in the spinal fluid. Great improvement was noted on the third day, but a severe headache occurred on the fourth day. Spinal puncture was again done, and 8 cc of opalescent fluid was removed. On the sixth day, the patient's temperature was normal and all medication was discontinued. No nystagmus, squint or double vision were present, the neck was not stiff. One week later, the patient went home, apparently well. She remained in good health to the time of writing, becoming pregnant six months after the illness.

[ABTRACTER'S NOTE—It is unfortunate that the germ causing the condition was not found. Apparently this was not a meningococcic meningitis. The author mentions streptomycin as gaining importance in the treatment of meningitis but does not say that he has used it.]

VOORHEES, New York

ON ORIGINAL WORK IN PLASTIC SURGERY IN NEW YORK STATE ELIOTT B HAGUE,
New York State J Med 48 617 (March 15) 1948

This is a historical sketch of the early work in plastic and reconstructive surgery in New York state. For the period prior to the Civil War there is "no record" up to the time of Dr Frank Hastings Hamilton (1813-1886). Most of the article is given over to eulogy of Hamilton's life and work. He was graduated from the University of Pennsylvania School of Medicine in 1835, became Professor of Surgery in the College of Physicians and Surgeons of Western New York and later held a like position in Geneva Medical College. He is said to have been a "master of . . . extirpative and reconstructive surgery." He evolved the principle of attaching skin grafts to periosteum to avoid retraction.

(this principle was the basis of successful plastic surgery about the eye as carried on by the late Dr John M Wheeler) Hamilton performed rhinoplasty by the Indian method of transplantation of forehead flaps In 1858, he extirpated the entire parotid gland, the effect on the facial nerve is not stated When Dr Holmes needed support for his theory of the cause of puerperal fever, Hastings "defended (it) with his pen" Hague concludes that reconstructive surgery was advanced by regional surgeons (specializing in pelvic, abdominal or traumatic surgery, etc) and that much of this work will remain in their hands There are many competent general and regional plastic surgeons

(ABSTRACTER'S NOTE—A strange omission concerns the remarkable work of the late Dr John O Roe, of Rochester, who flourished around the turn of the nineteenth century He was a master in his day and "set" many technics now in use)

VOORHEES, New York

A SIMPLIFIED METHOD OF OBLITERATING FRONTAL BONE DEFECTS D M LIERLE and W C HUFFMAN, *Laryngoscope* 59 61 (Jan) 1949

There are many ways to obliterate a bony defect of the skull by transplantation of tissue Lierle and Huffman fill the cavity with small pieces of autogenous bone The graft takes well, the shape can easily be molded, and no harm results to the underlying brain tissue

HITSCHLER, Philadelphia

POTENTIAL HAZARDS FROM RADIATION TREATMENT OF HYPERTROPHIED LYMPHOID TISSUE IN THE NASOPHARYNX LAURENCE L ROBBINS and MILFORD D SCHULZ, *Laryngoscope* 59 147 (Feb) 1949

Untoward effects of roentgen ray and radium treatment may not appear for years Not enough time has passed since the widespread use of the nasopharyngeal radium applicator to be certain that such effects will not appear in the future Harm has resulted from even an erythema dose, and this dose in some cases is less than that used in the nasopharynx Furthermore, it is difficult to determine the exact amount of radiation which reaches the tissues from the applicator Because of these potential dangers, the operator is warned not to use this means of therapy without due consideration

HITSCHLER, Philadelphia

THE USE OF SPLENIC EXTRACTS IN THE TREATMENT OF ALLERGIC CONDITIONS OF THE UPPER RESPIRATORY TRACT AND OF BRONCHIAL ASTHMA VIRGILIO SANGIOVANNI, *Pract oto-rhino-laryng* 9 79, 1947

The author presents a report on a series of 20 patients suffering from bronchial asthma and vasomotor rhinitis who were treated with endosplenina® (Istituto-Sieroterapico Milanese), a proprietary extract of the spleen The course of treatment consisted of a series of five intramuscular injections of 10 cc each, one given every other day The results were excellent in 95 per cent of the patients and good in 5 per cent The asthmatic and nasal disturbances disappeared for periods of from one to four months In 1 case, there was complete involution of the nasal polyps Although recurrences did occur, a second or third series of injections produced rapidly favorable results The author states the belief that the spleen exerts an endocrine influence and that allergic diseases are connected with hormonal imbalance, which may be reduced to a normal state by the administration of splenic extract

PERSKY, Philadelphia

Book Reviews

Die Klinik der Labyrinthitis und Paralabyrinthitis auf Grund des Roentgenbefundes By Prof Dr Med Horst Wullstein, Chief of the Ear, Nose and Throat Department of the Jung-Stilling Hospital, Siegen, Westphalia, Germany Paper Price, \$8 50 Pp 150, with 64 illustrations Stuttgart Georg Thieme, Verlag Imported by Grune & Stratton, Inc, New York, 1948 •

This book deals essentially with roentgen interpretation of pathologic processes of the internal ear. The first section treats of the methods of examination, in which Wullstein stresses the Stenvers position as being most favorable for accurate interpretation of otic pathologic conditions. While tomographs may be of value in a number of instances, the author relies on the Stenvers position for more exact delineation and structural changes. He states, however, that in spite of the most careful technic, certain conditions cannot be diagnosed with certainty. These are either a small circumscribed area of internal otitis or a diffuse internal otitis, involving only the mucosa of the inner ear. Other conditions involving the destruction of the bony capsule can readily be diagnosed, particularly when there is frank osteitis.

The second section deals with roentgen findings and, in many instances, with photomicrographs of many pathologic conditions. The roentgenograms are clarified by schematic drawings, which explain the condition present. The author begins this section by presenting the normal structures and proceeds with the discussion of many pathologic conditions, such as cholesteatoma and erosion of the various sites throughout the inner ear. The various disorders are illustrated by actual case histories, in which the entire course of the disease is briefly outlined.

The third section of the book is concerned essentially with symptomatology, diagnosis and treatment. Considerable emphasis is placed on the role of chemotherapy. Included is an extensive bibliography. The book, although confined to an extremely narrow field of otology, presents the newer thoughts on the subject of diagnosis and treatment of labyrinthitis and is of a considerable value both to the otologist and the roentgenologist.

Radiologic Exploration of the Bronchus By S di Rienzo, M D, assistant professor of Radiology and Physiotherapy, Chief of the Radiology Department of the Institute of Cancer, University of Cordoba, Argentina. Translated by Tomas A Hughes, M D, with a foreword by Richard H Overholt, M D. Price, \$10 75 Pp 346, with 520 illustrations Springfield, Ill Charles C Thomas, Publisher, 1949

This new work concerning the bronchus is devoted, as the title indicates, to the radiologic exploration of the tracheobronchial tree and pulmonary segments for clinical diagnostic and therapeutic aspects. The author is well qualified to present this material, which is well organized, rather clearly written and logically presented.

Numerous references at the end of each chapter supplement the material from the author's own experience in this field. The book is adequately illustrated, even though some illustrations are used as many as three times throughout the text. There are thirteen chapters in the book on embryology of the respiratory

tract, bronchial histology, anatomy of the bronchus, bronchographic characteristics of the normal bronchus, radiologic exploration of the bronchus by the contrast method, tomography, serial exploration, bronchopulmonary malformations, bronchiectasis, emphysema and asthma, carcinoma of the lung, hydatid cyst of the lung and suppuration. The book is completed by an index of authors, subjects and illustrations. This work should be of interest to clinicians, roentgenologists, otolaryngologists and thoracic surgeons in particular.

Rienzo has had many years of clinical experience with the subject he discusses, and for this reason the book merits some consideration. For example, a fine comparison of the various classifications of bronchial branches is contained for the reader's information. In passing, an exception may be taken to the statement that accidents nearly always occur with the use of contrast substances. With the measures used by most of the large clinics in this country, this is the exception rather than the rule.

Reconstructive and Reparative Surgery By Hans May, M D, F A C S, Assistant Professor of Surgery, Graduate School of Medicine, University of Pennsylvania. Foreword by James Barrett Brown, M D, F A C S. Price, \$15. Pp 964, with 963 illustrations, 17 in color. Philadelphia F A Davis Company, 1947.

Plastic surgery received a new impetus during and immediately after World War I, then came a settling-down period, which continued until World War II. Then, the enormous number of casualties and persons with maiming of various parts of the body brought an increasing number of plastic surgeons into the field of repair and reconstruction. This book is testimony to the amount of work now being done to make the lot of the *blesse* happier.

This volume will appeal to the general surgeon because it is based on a thorough understanding of surgical principles. These general principles make up Division I and illustrate free tissue grafting, shifting of tissue and transplantation. Wound healing, the care of burns and correction of scars receive special attention. Division II is concerned with the head and neck, especially with cosmetology and defects. Division III is confined to the trunk and considers procedures involving the female breasts, the genitalia and the sphincter ani and with the building of a new, extrathoracic, esophagus. The subjects considered in division IV are the hand and foot and the muscles, nerves and blood vessels which supply these members. The bones and joints are, of course, objective factors in any attempt to repair the limbs. In division V are cited about 126 cases. Black and white photographs illustrate the condition before and after the prosthesis is fitted. There are an index of illustrations and an index of subjects covering the entire book. At the end of each chapter is a complete bibliography. This is an excellent reference book, but it may be recommended for general reading also, since the style is interesting and the material comprehensive.

Histology and Histopathology of the Eye and Its Adnexa By I G Sommers, M D. Price, \$12. Pp 784. New York Grune & Stratton, Inc, 1949.

Since a good textbook on ocular pathology has long been needed, a new work on the subject is a matter of considerable interest. Unfortunately, while the book does mark an advance, it leaves something to be desired.

The normal histology and general pathology of the eye are discussed in two short sections. The third section forms the body of the book and covers ocular

histopathology Each chapter is followed by an extensive list of readings from the source material and by a most comprehensive bibliography, which gives evidence of tireless scholarship

There is much valuable information to be found in the book, but it is not always expressed in a manner easily grasped by the novice The illustrations are not as numerous as the subject requires and have, in general, a lack of distinctness which impairs their usefulness

Aside from making use of this book for the readings, the bibliographies and the convenience of a single small volume, the average student may still turn to the sections on pathology incorporated in the volumes of Duke-Elder's "Text-Book of Ophthalmology"

Surgery of the Eye Second edition By Meyer Wiener, M D Price, \$12
Pp 426 New York Grune & Stratton, Inc, 1949

This highly readable and eminently practical book does not cover every surgical procedure in ophthalmology, but it does give those which the author has used successfully and can recommend A single method, and in some instances several methods, are described for each condition requiring ophthalmic surgery

The exacting requirements for a book presenting surgical technics are handsomely met by numerous, excellent illustrations and by clear, detailed exposition This achievement is in the tradition of Meller In addition, the book is noteworthy for its many and ingenious suggestions

To the material in the first edition, published in 1939, are added descriptions of goniotomy for congenital glaucoma, implantation in evisceration, with preservation of the cornea, and corneal transplantation, in which the Wiener punch is used to obtain mechanically a beveled edge It would have been interesting to have had more detailed description of the postoperative care, particularly in the matter of corneal transplantation, in which such care is so important but its omission does not detract from the general excellence of the book

Directory of Otolaryngologic Societies *

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